The Long Range Hunting Series

The Practical Guide To Reloading

Nathan Foster

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(1st Edition)

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Dedication

This book is dedicated to the memory of

Adam Faulkner.

Acknowledgements

I would like to convey special thanks to my wife Stephanie for sharing the heavy workload throughout the years, whether that be at the reloading bench or in the field, editing the books or trying to keep everything together at home.

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I would like to thank Lisa Kelly for her excellent cover designs throughout this series and her unending patience with me during each process. Oh the torture - a scenic cover or reloading workbench? How about a mountain scene with a man reloading as he watches the sun set? Will the world ever be the same again?

I also would like to thank Scott and Dan at Reloaders Supplies New Zealand for helping Steph and I with ongoing technical (and sometimes moral) support. This has been invaluable to us over the years and especially during the book series.

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Lastly, I wish to thank all of you who have purchased our books and supported Stephanie, Riley and I throughout the book series and as we continue to move forwards. Steph and I struggle to find the words to convey our gratitude for your support. Thank you all so very much.

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Introduction

A haiku is a type of Japanese poetry which tries to encapsulate the essence of a moment in as few words as possible - while painting as large a picture as possible. To a great extent, this poetry seeks perfection through simplicity.

Well, this ain't no haiku, but I have tried my best to keep things simple. This is by no means the first book ever written on the subject of handloading. Most other books cover the basics, then supply fifty million pages of load data for cartridges you will probably never ever shoot. Some books start with the expectation that the reader has already developed skills, skipping the basics of reloading and jumping straight into advanced topics, which may or may not be of use depending on where we are at. The reader may come away thinking that he needs reloading attachments mounted to each finger. If he keeps this up, he will become part man and part machine - Roboloader. Others go too far down the intellectual route - very serious pontificating stuff this is.

It gets confusing.

In this fourth book of our series, my goal is to teach you how to make your own ammunition. I have provided the steps to help you achieve optimum accuracy from your rifle, whether you are just starting out or are already midway through the handloading journey. Understand this: I don't really see extreme accuracy as being the result of advanced handloading procedures. To me the goal is always the same - to keep things enjoyable, to keep it simple. In my experience the entire concept of advanced handloading procedures for extreme accuracy is somewhat misleading. A more honest term would be problem solving steps. The process of obtaining extreme accuracy is a matter of

problem solving, and beyond this I don’t fix what ain’t broke - unless I just want to play. The process of handloading should not be stressful. It’s not meant to be something you dread or will never be able to do properly because you don’t have time for all of that technical mumbo jumbo. Once you are set up and have an understanding of the basics, you will be able to knock up a batch of super accurate ammunition in the space of time that it takes to drive to the gun store and purchase a packet of wossname. The stuff you were never ever really that fond of since that deer got up and ran away last fall.

Before we go any further ahead it is vital for you to understand that in order to achieve optimum results, your rifle will need to be up to the task. Good handloads cannot make up for a bad rifle. This book series was written in chronological order, starting with how to choose a good rifle design (rifle fundamentals), then how to choose a cartridge which in this particular instance had a bias towards (but not exclusive to) long range hunting. With these factors addressed, the reader could utilize my third book to set about testing, accurizing and maintaining the rifle. We are now at a point where - fingers crossed - we have a good rifle and can move on to handloading. There is still a chance that the bore is a dud. We learned about this in books one and three; we are pretty savvy now and we have realistic expectations. If we follow the steps in this book and fail to achieve desirable results we can then set about identifying problems and hopefully eliminate them, using this book combined with others in the series.

The one topic not covered in this book is shooting technique. This will be the topic of the last book in our series. I often think it should have been the first - a catch twenty two situation.

Some of you will be fine, others will need a good deal of coaching which is nothing to be ashamed of. Some folk can't or don't want to be helped of course - bless them. Nevertheless, it is important that you understand that accuracy is a function of three main factors: rifle accuracy, optimum ammunition and shooting technique. It's a love triangle that cannot be broken.

SAFETY WARNING

When women run or jog, they jiggle up and down. They dislike it, men love it. Now that I have got your attention - please read this safety section, your well-being depends on it.

Handloading is a potentially dangerous activity!

Within this book, I have talked about exploring maximum loads as they pertain to:

1. Published reloading manuals.
2. Finding a safe maximum stopping point when developing loads for the individual rifle.

Most books written on the subject of reloading go no further than the discussion of maximum loads as pertaining to load manuals. This helps protect authors against any liability.

If I am to help you fully achieve your goals, I need to explain the full processes generally undertaken by myself and other expert individuals when handloading. To this end I have to explain the process of exploring what I call a safe maximum stopping point for the individual rifle, which may or may not be above book maximum.

A major problem with determining safe maximum is that this process is completely reliant on the competency of the individual. We do not have proper testing equipment such as a piezoelectric pressure sensor to measure pounds per square inch (PSI) or a copper crusher gauge to measure copper units of pressure (CUP). All we have are our eyes and intellect.

The age of a rifle, its design and its general condition can each have a profound effect on safety. It is very important to research the design of your rifle to find out what pressures your firearm was generally rated for. As an example, many older rifles were rated to operating pressures of less than 30,000 PSI. A modern rifle which replicates a vintage design may still have the same pressure limitations, while in contrast to this a modern rifle chambered for a potent high velocity magnum may be rated to 63,000 PSI. So, the first step is to research your rifle. This book also has a section dedicated to vintage military rifle pressure considerations.

The process of exploring individual rifle maximum along with methods for the reading of pressure signs contained within this book pertains only to modern bolt action rifles, chambered for modern cartridges. Furthermore, I cannot condone these practices, having no control over the competency of the handloader nor any access to the rifle in question.

Rifles are not unlike horses - immensely dangerous creatures under the wrong conditions. Does this mean that authors should refrain from writing books about horsemanship or that we should ban horse riding? Of course not. Nevertheless, we need to be vigilant of the potential dangers and take appropriate countermeasures to avoid serious or potentially fatal injuries (the same as driving a car).

You are entirely responsible for the consequences of your actions. Reloading manual publishers set safe margins for a reason - having no control over the age of rifles, condition of rifles, or individual chamber measurements. Please understand that many rifles do reach maximum pressures well within reloading manual suggested maximums, due to short throated chambers and for various other reasons. Reloading manual publishers cannot be considered overly cautious, their caution is well justified.

Where any of my example loads are given in this book, I do not condone nor recommend these loads.

As a final warning, please be aware that powder measuring scales, both digital and balance beam scales can suffer immense discrepancies. This is explored in further detail within this book.

Over the past year alone I have had mail from two readers, both of whom had their rifle actions blow up as a result of handloading mistakes. In one instance, a shooter lost the use of his master eye due to shrapnel. Please, please be safe.

Goals

To begin with, I believe we need to establish a clearly defined set of goals. We have to ask ourselves: Why are we handloading?

The following are what I consider to be our core goals - not in any particular order of priority, apart from the first as it pertains to hunters:

- To optimize our ability to produce fast, clean, humane killing via increased accuracy, optimal velocity and tailored projectile designs.
- Pleasure, the enjoyment of being able to make our own ammunition and fine tune performance.
- Optimize rifle accuracy, the ability to affect and therefore alter barrel harmonics.

- Lower extreme velocity spread (ES) for long range shooting.

- Select bullets not generally or easily available to the factory ammo user.

- Cost savings. While our initial outlay may seem somewhat expensive, we can save a good deal of money long term (although the enjoyment can cause a significant increase in shooting!).

At the same time I believe that we should be aiming to achieve these goals with the least amount of fuss.

Regarding my first priority, I really believe this is of extreme importance. Too many times I have seen folk try to shoot factory ammunition out to ranges beyond the point at which the ammunition can be expected to produce clean kills. Accuracy may be limited, velocities may simply be abysmal at extended ranges and the bullet designs can at times be hopeless. As the quality of our optics has increased over the years along with increased cartridge power, the potential ranges we can hunt to have increased accordingly. But there are vital steps we need to take when hunting at extended to truly long ranges. Sometimes we may find a suitable factory load which is a boon, though often we have no choice but to handload.

As a simple example, the 6.5x55 Swedish Mauser cartridge can be coaxed to produce clean killing on light to mid-weight deer species out to ranges of 600 to 800 yards in the hands of a seasoned shooter - utilizing the 140 grain A-MAX bullet driven at around 2750fps. Tougher bullets can be used for closer range work such as the 140 grain Nosler Partition and right in between the A-MAX and Partition we have the Hornady 140 grain SST. A trio of highly effective projectiles to suit a variety of situations. In contrast to this, a basic off the shelf load for the Swede will typically consist of a 140 grain soft point bullet yielding a muzzle velocity of 2400 to 2450fps. The load is not tailored to the rifle - accuracy is simply a roll of the dice. Some rifles will shoot the load well, others may not. Both, velocity and energy are abysmal, resulting in narrowing wounds at ranges beyond 100 yards, becoming much worse beyond 200 yards. Increased wind drift may result in rear lung, liver or gut shots out at ranges of around 250 to 300 yards. To top this off, some supposed gun expert comes along and declares the Swede to be an effective killer, boasting incredible BC's which puts it on par with the .270 Winchester - total nonsense. The same goes for the often underloaded .260 Remington. Based on this advice many an animal has suffered at the hands of a factory ammunition user with his 6.5 caliber death ray, which in reality is little more than an undersized .30-30. The solution - handload!

Sometimes you will hear the argument "I don't have time to handload" from the guy who has all the gear and reckons he wants to shoot to a million yards. Well, I would rather he took an hour to load a batch of ammunition than leave an animal to die over several hours. The whole time argument is rubbish within this context. If we exchange the word time for the word compassion, we paint a whole different picture.

Handloading is simply an extension or progression of our primitive ways. Whether we used a sling and stone, a spear or bow, to hunt effectively our tools need to be refined and honed to suit the job at hand. The right size or shape stone, the right

tip and cutting edge, the balance of a spear, the weight and fletching of an arrow. And there are still tribesmen who hunt this way - dedicated hunters within a tribe, the handloaders of the jungles and plains. We differ from other animals in that we do not have claws, fangs or speed. Our strength is intellect, intellect that allows us to utilize tools to hunt with. Whether we live in a mud hut or apartment building, the tribal hunter and the modern hunter share the same attributes. This intellect puts us at the very top of the food chain and comes with a good deal of responsibility. So, it really does not matter whether we are sharpening a spear to be used out to 20 yards or are checking on the concentricity of a rifle cartridge to be used at long ranges - a good hunter will always hone and refine his tools. This is a sacred process, it’s in our blood, and to fight it is to fight who we are.

The shot of a lifetime - This Fallow buck was taken at long range utilizing carefully handloaded ammunition.

Basic tools

I would like to start with a very basic kit list. This really is the most basic of kits but in most cases will be enough to allow the novice to produce accurate ammunition. I tend to mix and match my kit (brands) and have not generally embraced package deals. Nevertheless, there are some good package deals available to handloaders.

Basic tool list

- Bench / work space.
- Journal.
- Vernier, dial or digital caliper.
- Single stage reloading press.
- Three die set (full length sizer, neck sizer, seating).
- Shell holder.
- Case lubricant (good to have both wax and graphite).
- Cotton buds.
- Powder funnel.
- Case trimming tools.
- Primer pocket uniformer and cleaner.
- Poly pads for case cleaning (e.g. Scotch Brite).
- Tray or block to hold ammunition.
- Reloading scales.
- Kinetic bullet puller or other bullet pulling tool.
- Allen keys to adjust dies (normally come with dies if needed).
- Two spanners (to adjust or remove decapper assembly from some brands of dies such as Hornady).

To this we add:

- Brass.
- Primers.
- Powder.
- Projectiles.

Other tools may include:

- Ammunition concentricity gauge.
- Ball micrometer.
- Comparator for determining cartridge overall length (COAL).
- Hand primer seater.
- Flash hole uniformer (high end).
- Case neck turner.
- Automated equipment including powder dispensing and or case trimming type units.

Some of our advanced tools can be useful as a means to increase accuracy or aid efficiency. However, few are absolute necessities despite what others may have you believe. The one tool on this advanced list that I would highly recommend is a good ammunition concentricity gauge which we will discuss in a later chapter.

Having listed the basic equipment for reloading, we can now take a look at individual items in detail.

Work space

If possible set up a dedicated work space with a sturdy bench system. Those who live in apartments may simply have to stow their kit in plastic storage bins and work at a sturdy dining room table. Those who live in a shoebox may prefer to work with hand dies. Others who have the space, will prefer a dedicated work area.

It can pay to reload within the house, as opposed to a workshop or shed area with poor environmental qualities (e.g. dampness, or breezes which can affect scales). Security beyond the confines of the home can also be problematic, as opposed to a dedicated work space in a spare room or area of the house.

My workbench is set level and is braced and screwed every which way to prevent (as much as possible) any disturbance to equipment. In antipodean lingo - it looks just like a bought one and a blind man would be pleased to see it. It can also pay to place a rubber or carpet mat under your work area to lessen the blow, should any brass or tooling fall to the ground.

The workspace is a very important aspect of handloading. A solid level bench and good storage for equipment are essential. It doesn’t have to look the part - some folk can afford the whistles and bells, others need to recycle a kitchen table or sturdy office desk. If you cannot afford a luxury workstation - not to worry, try to do the best with and be grateful for what you have.

The reloading bench. This one has a steel frame and ply board top.

Keep your work area clean and tidy. A cluttered work area can lead to confusion and mistakes. A classic example of this is having multiple tins of powder on your workbench at the same

time. If you use the wrong powder, you could blow up the rifle and injure yourself. So if you're not using it, put it away. It may seem like a chore - too bad. This is your little gun shrine where all the good stuff happens. Treat it with respect!

Summary of Key Points:

- Try to set up a dedicated work area if possible.
- No breezes, good environmental conditions.
- Work bench needs to be as sturdy as possible.
- Keep work area tidy.

The Press

The press is the heart of our reloading operations, holding the reloading dies in place. The cartridge case is mounted on a ram and fed into the resizing die where it is re-formed, either at the case neck or the full case body. After this the case is primed, charged and fitted with a new projectile. The press should be of a sturdy construction, so that it will handle the resizing operation without distortion or potential breakage, even if a case is difficult to resize. Having said this, any major difficulties in case sizing should be addressed immediately. Reloading should not be an exercise in brute force, unless you are training to be “strong like bull”.

There are five basic types of reloading press. These include:

- Single stage (the focus of this book).
- Turret.
- Progressive.

- Arbor.
- Hand press / hand tools.

A single stage press is a most basic design and is slower than a turret or progressive press with multiple and partially automated stations. However, a single stage press design allows for optimum control over the reloading procedure. For example, powder charges dispensed from a small hopper during one of the progressive stages may not be as accurate as weighed charges. On a single stage press, the handloader weighs and physically observes each powder charge. In plain terms, the single stage press allows the handloader to perform ongoing checks. This is helpful for those new to handloading and also advanced operators looking for fine control.

The very basic and robust Lee Classic Cast single stage press.

A turret press features multiple stations within its head. Each time the press handle is operated, the turret head rotates through the various stages of case sizing, primer seating, powder charging and bullet seating.

A progressive press also has multiple stations within its head, however it is the base that rotates. These press systems can help save time provided the cartridge cases do not need trimming. As mentioned, the downside of automated press systems is that sometimes the automated powder dispensing system will not weigh accurate charges which can in turn affect rifle accuracy. These limitations may be as a result of the powder dispensing unit design or quality, or may simply be caused by a powder that does not meter well. Due to the fact that the focus of this book and book series is on the goal of optimum (sometimes called extreme) rifle accuracy, I highly recommend the use of a single stage press to begin with, utilizing an automated press later if funds allow.

An arbor press differs from its siblings in that it is not threaded to accept reloading dies. Instead the arbor press is designed to be used with Wilson brand benchrest dies and boasts great portability for those who wish to make and test ammunition in the field. Wilson dies are a simple design for neck sizing and seating bullets with minimal force, negating the need for any form of locked die. We will discuss Wilson dies in greater detail further ahead.

Hand tools can be very useful where a portable (field) reloading system is required or if your accommodation space is severely limited. Lyman have made some of the most elegant hand reloading tools, but alas their range is now limited to cowboy type chamberings such as the .30-30 WCF. I have owned and used one of these tools for many many years (.308 Winchester). The design of the tool however is not conducive to extreme accuracy. Unfortunately the plier action of the tool does not push the case squarely into dies, this effect being at its worst

during bullet seating. Nevertheless, accurate ammunition can be made if great care is taken during neck sizing and bullet seating operations.

The Lyman 310 hand tool.

The slight offset of the case rim as the case is fed into the die can cause concentricity problems. Nevertheless, this tool is very handy.

Lee make two hand tools, the Breech Lock Hand Press and the Lee Loader. Lee's Breech Lock hand press is somewhat similar to the Lyman 310, both reminiscent of a set of pliers. However, the Lee press is a giant forearm sized unit and aligns the case squarely to the die, rather than starting off center in a true plier motion. This hand press is very inexpensive and the current model makes use of the Lee quick change die system. The Lee hand press (or any hand tool) can lack the leverage power of a mounted press during difficult full length sizing operations and also to some extent, during neck sizing operations with the Lee Collet neck die which requires a good 25lb force in order to neck size cases. To aid in such operations, Lee have incorporated some extra length and heft into the design. Those who neck size most of the time and full length size only once in a while will find this press very easy to work with.

Lee’s second tool, the Lee Loader is similar to the Wilson system. The press is done away with altogether, utilizing a mallet or arbor press for all operations. In essence this kit is little more than a set of dies with some additional tooling and should not really feature in the press section of this book. Nevertheless, the Lee Loader is a system that deserves consideration. The slang term for this unit is the “whack a mole loader”, and outwardly at least the system does appear quite rough. Yet, like much of Lee’s equipment this system is capable of turning out first rate ammunition. The Lee Loader is somewhat slower than other systems, but it is the most compact of all.

While the focus of this book is towards the use of the single stage press, please do not overlook the merits of hand tools. I have already mentioned that hand tools are great space savers and can also be taken into the field. Along with this hand tools can be a great way to introduce newbies to the game. Many of you will have friends that “would like to handload one day”. And of those friends some will never take the first step, as it all seems too complicated or time consuming - even if this is mostly an illusion. Hand tools can help overcome some of these mind blocks and can make for a great gift - with the potential for very accurate ammunition. Hand tools can also be great fun to use and are the most sociable tools, as the operator can sit with family - mum knitting, dad reloading, kids polishing cases under threat of no dessert. On a more serious note, being a more sociable tool one must be very careful with regard to safety due to the potential for distraction.

Summary of Key Points:

- Familiarize yourself with the varying press designs.

- A single stage press is ideal for learning and for producing accurate ammunition.
- Other press types have great merit for certain applications.

The single stage press

Single stage presses can be further categorized into O and C types. The O type has a rectangular frame, somewhat like the letter O, while a C type press is as its name suggests much like the letter C. These days the O type press is viewed as superior due to its strength and due to the fact that it cannot flex off center over time. This helps to ensure that the reloading dies are properly aligned to the ram for optimum concentricity. That said, some older C style presses including Hornady Pacific and Bair were built incredibly strong; and many of these old presses are still producing concentric ammunition and are often available second hand at very cheap prices.

My old Bair C-frame press, so many good memories.

Concentricity is the name of the game when it comes to rifle accuracy. This begins with the press, however it is extremely difficult to test press concentricity without specialized tooling. To add further difficulty, the brands which once stood head and shoulders above other brands can no longer claim such lofty heights. This is no different to the rifle brands which we discussed in book one of this series.

These days I find that the quality of a press must be measured on an individual basis, rather than making assumptions based on brand. This I believe is an important consideration. Fortunately all of the major brands have merit which leads me to my second point of consideration. If you find that your press has some flaw, contact the maker and have it rectified. One of the best aspects of the reloading game is that all of the competitors offer excellent customer support. This is one generalization that seems consistently valid - reloading companies aim to please.

Besides older presses from the major brands, the brands I currently recommend are Lee Classic Cast, Hornady Classic, Lyman Orange Crusher, Redding, RCBS and Forster Co-Ax. Lee was once considered to be very cheap and nasty but the truth is, Lee is proving to be one of the very best manufacturers of reloading equipment. Those who buy Lee brand reloading equipment can have their cake and eat it - regardless of what some accuracy aficionados may state. The proof can be found in the concentricity of loaded ammunition.

The Forster Co-Ax press is a premium item. Its design is neither a C or O frame and is more a combination of both. The two most unique features of the Co-Ax press are the shell holder and the method in which dies are mounted to the press. The shell holder is simply a spring loaded plate and can float side to side. The reloading dies are allowed to float front to rear. This float in the shell holder plate and die housing helps to optimize cartridge concentricity.

When mounting a die into a Forster press, the die is simply pushed into a slot in the press. Reloading dies are not held in place by any other means. Die changes can be performed in a flash. The size of the locking ring used on the die is however critical in order to avoid excessive play as opposed to a small degree of useful float. Forster sell packs of die locking rings to allow handloaders to use this press with die brands other than their own.

The Forster Co-Ax press. This one has a Redding die fitted. Note how the Redding die has been pushed into a slot in the press (see die locking ring). The die is not held by any other means.

A Hornady single stage Lock N Load O-frame press.

In recent times it has been said that some brands such as RCBS are now made in China. This is not true. Some smaller, lesser parts may well be sourced from China along with electronic equipment, however RCBS continues to machine presses and dies in the state of California. There was a rumor that RCBS may have at one point experimented with sourcing the basic press castings from China, but again all machining and machine tolerances are the responsibility of staff within the California

plant. Why did these rumors spring forth - because of occasional quality control issues which can happen during any manufacturing operation. So again, treat presses (and other reloading kit) on an individual basis.

All of the presses I have mentioned utilize the same generic shell holders and dies. The one exception being Forster who have done away with the traditional shell holder, utilizing a unique design as a means to aid concentricity.

If you are just starting out, I suggest you purchase one of the basic O type presses. A simple Lee Classic Cast Press with 7/8x14 threads is a good starting point. For those who wish to pursue a premium press design, the Forster Co-Ax is highly recommended. I cannot state that the Forster will produce more accurate ammunition than the Lee press, however the Forster is most certainly an elegant and innovative press design.

Summary of Key Points:

- A basic O type single stage press with 7/8x14 threads can produce excellent ammunition.
- Press quality should be determined on an individual basis rather than brand versus brand.

Mounting your press

While it is common to bolt the press down to a workbench, many of you may prefer a more portable system. I bolt my presses to a block of 6x2” timber roughly 12 to 15” in length. I then G-clamp the timber block to my workbench. With this

system I can quickly shift the press and take it to another location if I need it handy or if I need extra bench space.

Press problems and concentricity

As suggested, measuring press concentricity is not the easiest of affairs. One system I have come across from other operators is to wind the die down to the shell holder, then back it off just a touch. Following this, a light is held to the rear of the shell holder (back lit). The operator can then observe whether the gap (light) is even, changing position to check the 3 and 9 o'clock positions. I have also tried coating the rim of the shell holder and bottom of the die in grease or engineer's blue. A piece of clear glass or plastic can then be used to record an imprint, sandwiched between the die and shell holder. This sounds all very technical, but the truth is the result is little more than a visual impression, lacking any precision. To be honest, I cannot see how a great degree of misalignment can be expected when both the top and bottom of the press are drilled in one continuous pass, top to bottom.

We can however check for side play (or wear if second hand) in the ram. Slop is the term I generally use. The only bug bear is, an ever so slight degree of slop can be useful, allowing the cartridge case to self-center in the die. The top of the press also needs to be machined flat and at 90 degrees to the bore of the press, but this again is very difficult to measure in practice. Parts breakages on presses are not so common, but as previously mentioned press makers are generally eager to please and will rectify breakages without fuss. The plastic spent primer catching systems do sometimes fail to catch primers or sometimes break during assembly. In the long list of priorities I do not see this as a major problem. I am more concerned with the accuracy of my ammunition.

The main point I would like to convey here is that if you are a beginner on a budget and shopping second hand, watch for excessive side play in the ram.

Summary of Key Points:

- It is difficult for the layman to truly determine the concentricity of a press.
- Shell holder float can be utilized for self-alignment / optimum concentricity.

Quick change systems

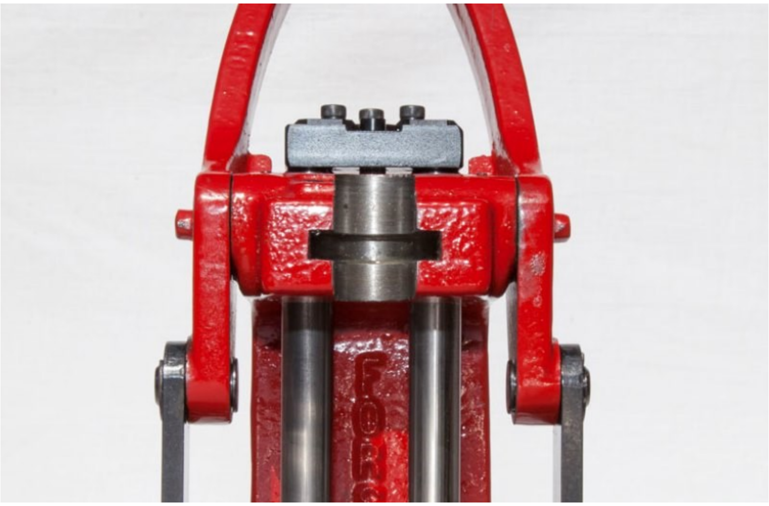
In recent years there has been a trend toward presses which utilize quick change dies, particularly from Hornady (Lock N Load) and Lee. The reloading press is threaded oversize; an adaptor is then mounted in the press and the die screwed into the adaptor. This adaptor can simply be unlocked and removed in quick time. Personally I don't see the need for speed in this regard - are we really in that much of a hurry? On the other hand, Lee dies do not have a fully lockable lock ring on their reloading dies (discussed ahead) which is one reason why these dies can seem "cheap". But used in conjunction with a quick change adaptor, the die is locked in place (to a large extent) and the handloader need not fear losing settings. So in this sense, the Lee quick load system can be beneficial.

Hornady's quick change Lock N Load system.

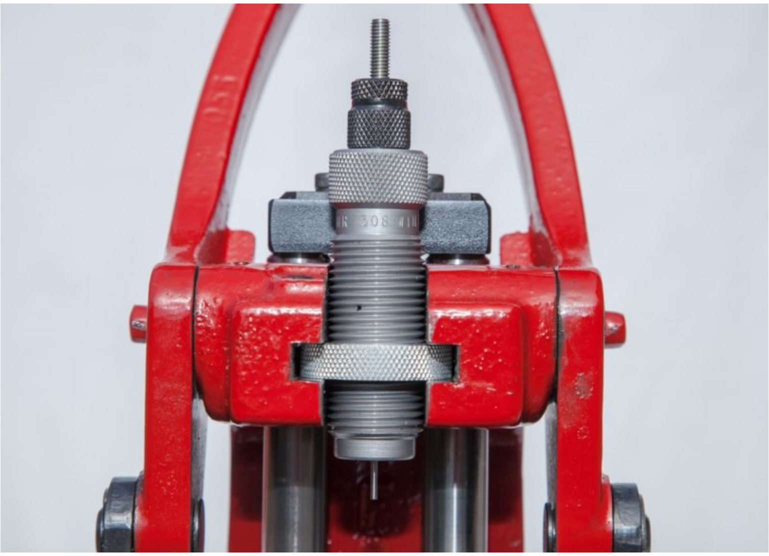
Lee offer both a traditional 7/8 x 14 thread press as well as their breech lock (quick change) press, and if choosing a Lee single stage press it is important to understand that although both presses look the same, the threads do vary between these two distinct models. If you purchase the quick change system, you will also need to purchase the breech lock collets to make

use of the system. That said, the adaptor can be left in the press and the dies removed from the adaptor in the usual manner. I have a traditional Lee press without the quick change arrangement which by its design can also tackle the big 50 BMG.

As previously mentioned in the press section, the Forster press is in essence a quick change system as a result of its floating design.



A Forster Co-Ax press showing the die housing- a basic but carefully milled cut away which enables instantaneous die changes. The primary purpose of this system is not quick changes and is instead designed towards optimum concentricity. Nevertheless, the result is an ingenious quick change system.



Close up of the Forster die mounting system with a Forster .308 Win neck sizing die slipped in place.

Summary of Key Points:

- When press shopping, check the threads of the press - is it traditional or does the press utilize a quick change system?
- Quick change can be useful but can cost extra if the system is to be utilized with multiple die sets (cost of collets).

The shell holder

A shell holder is required for the extraction of cases from resizing dies. The cartridge case is placed into the shell holder, then fed in and out of the sizing or seating die.

Shell holders are generic. A Lee shell holder can be used with a Hornady press and vice versa. An RCBS shell holder can be used with a Hornady press and so forth.

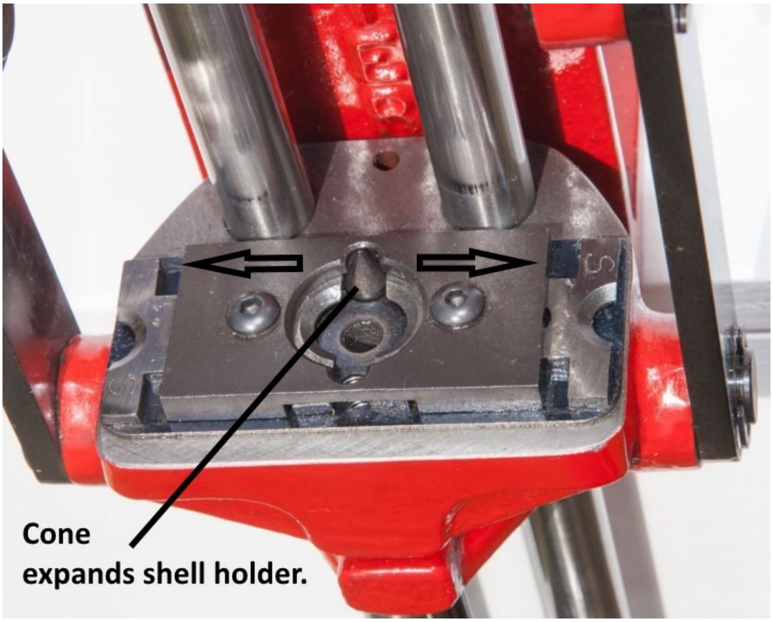
For those delving into the depths of rifle accuracy, an important aspect to note is that the cartridge rim needs a degree of side play or float for self-alignment within the shell holder. Shell holders are generally held in place by a spring clip in the ram. When setting the shell holder in place, the operator snaps the shell holder past this bump. This is a good system but if the case rim has no side play within the shell holder and the spring clip is so aggressive as to lock the shell holder solidly in place, it can be difficult to obtain self alignment. It is important to check this aspect of the press, making sure the case rim can be wriggled slightly when mounted in the shell holder or in lieu of this the shell holder wriggled slightly in the press. There are no easy fixes for rigidly fitting case rims.

There are two points to remember with regard to shell holders. The first is that you must obtain the correct shell holder for your cartridge, as shell holders vary in shape depending on the cartridge design. This information can be found from each manufacturer. The second point is that as you obtain multiple die sets and increased kit, you may end up with two or more shell holders of the same type. These shell holders may look the same but they may have slightly different tolerances which can affect handload tolerances such as seating depths. It therefore pays to nominate which shell holder you intend to use and either isolate other shell holders of the same type or perhaps dab a bit of paint on the outer edge of the shell holder you intend to use.

Lee shell holders. The number 5 shell holder accommodates several wide rimmed cartridges including the 2.5" magnum family (e.g. 7mm Remington Magnum). The Number 2 shell holder accommodates cartridges of the .308 Win and .30-06 Springfield family.

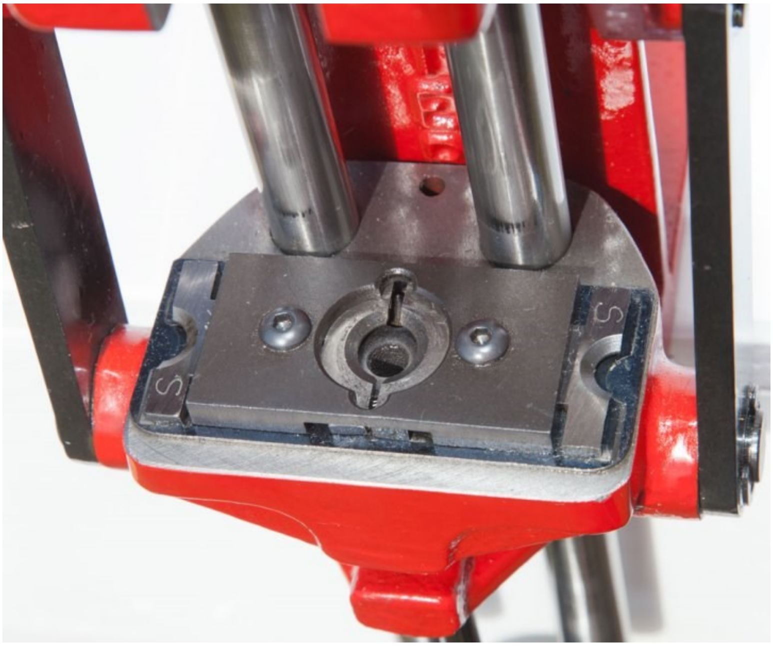
Not to be confused. All three of these are Lee Number 5 shell holders but each serves different purposes. From left to right: Lee press shell holder, a Lee case trimming shell holder and a Lee priming shell holder used with hand priming tools.

Forster do away with the traditional shell holder system on their press, utilizing their own unique floating design. Care must be taken with this system as the shell holder plate can become damaged if a case becomes stuck in the press and the handloader attempts to free the case from the die using extreme force. If such damage occurs, the shell holder plate needs to be replaced. Forster also produce an adaptor so that their press can be used with traditional shell holders. Although I should suggest that this adaptor and a traditional shell holder is ideal for difficult sizing operations - it is perhaps more prudent to suggest that handloaders try to seek the cause of why case sizing is proving difficult before adopting such counter measures.



The Forster Co-Ax shell holder plate. When the plate and ram are at their lowest position, a cone forces the shell holder open. The hand loader is then able to simply place a case within the plate and raise the ram to activate the shell holder.

The Forster shell holder plate will handle most case designs. The jaws of the shell holder come in two basic sizes - small and large. To change from a small to large shell holder or vice versa, the plate must be disassembled and the jaws swapped around (see photo). To some, this is a slight inconvenience. Where great speed is required, a second plate can be purchased for quick changes.



In this photo, the ram has been raised slightly, allowing the jaws of the shell holder to close and capture the rim of a cartridge case. Note the outer edges of the plate showing the small jaws (engraved with the letter S), suited to handloading small cartridges like the .223 Remington. The jaws can be swapped around to suit most rifle cartridges. Redding also make an adaptor which allows the Co-Ax press to be used with traditional shell holders.

As a last note, Arbor presses (and Lyman hand tools) do not utilize any form of shell holder as a result of their design.

Summary of Key Points:

- Obtain the correct shell holder for your cartridge.

- If you own two or more of the same shell holder for a given cartridge, nominate one shell holder to be used and stow others away.

Reloading dies

There are several types of handloading dies to cover a range of operations. The three dies we will be focused on include:

- Neck sizing.
- Full length sizing.
- Bullet seating.

A neck sizing die does as its name suggests and sizes the neck of the case only so that it can grip a new projectile. The rest of the case remains unaltered to fit the chamber of the rifle as closely as possible for optimum concentricity. That said, a neck sized case will not always produce 100% contact within the chamber as cases display a level of spring back. In other words, during ignition the brass case expands to seal the chamber, but at the same time the case bounces off the chamber wall and springs back to slightly smaller than chamber dimensions; although some case dimensions may remain at full chamber diameter. Where the case dimensions remain the same as the chamber dimensions, the bolt may feel somewhat tight to close but is hopefully still operable. After continued usage or hot loading, the brass may eventually need full length sizing to regain smooth feeding.

A full length sizing die resizes the neck and entire case body. This results in a smooth feeding cartridge. The down side of full length sizing is that it can very often have a negative effect on concentricity, either as a result of the case forming process or as

a result of final case size being much smaller than the chamber. Nevertheless, there are times when a full length die must be used. Examples include: pump and lever action rifles with low extraction power, Blaser rifles with low extraction power and semi or fully automatic rifles. As previously mentioned, even in bolt action rifles (after a period of neck sizing) cases may lose their ability to spring back, becoming tighter and tighter, and the bolt of the rifle becoming more difficult to work. Once this happens and feeding becomes difficult the cases will need full length sizing. A tight chambered rifle may also require continued full length sizing for smooth feeding.

In bolt action rifles, if a high degree of run out (poor concentricity) is introduced due to full length sizing operations, the case will need fireforming. This can be done with low wear / stress using Trail Boss powder (discussed further ahead in this book), after which the cases should be neck sized.

Redding produce two alternative systems for full length sizing, differing from traditional full length sizing dies which Redding also produce. These options include a body sizing die which does not neck size, utilizing a separate neck sizing die to complete sizing operations. The second system is the Type S full bushing die with floating neck bushings. Both systems are designed to aid concentricity when full length sizing is required.

Quite often you will come across handloaders engaged in heated debate as to which method is better, neck sizing or full length case sizing. I would encourage you to buy both dies, ultimately arriving at a 3 die set (with a seating die). You can then argue with your rifle as to which system is better! We will address more pros and cons and potential issues as we get further into this book - I don’t want to scare you off in the first chapters!

A bullet seating die does as its name suggests and is used to fit a new projectile into the cartridge case. This die has to not only

seat the bullet, but it also needs to seat it straight. A bad seating die which misaligns projectiles can ruin accuracy, so this is yet another critical aspect of handloading.

Many brands of seating die also contain a crimp component. In essence, the case mouth is crimped to grip the projectile; normally at a cannelure within the projectile design. Crimping is not so common as it once was but still remains an important operation if handloading for tube magazine fed rifles such as the Winchester and Marlin lever actions. Unless you crimp the cases of cartridges for these rifles, the projectile can be pushed into the case neck under recoil. By the same token, crimping can also be useful for high recoiling rifles if projectile movement within the case neck proves evident. Semi or fully automatic rifle ammunition is also generally crimped, as is pistol ammunition.

If no bullet cannelure exists, light crimping can be achieved without too much projectile deformation. I do however recommend handloaders generally refrain from crimping unless it is completely necessary as pertains to the lever actions.

Crimping can however be used as a means to experiment with cartridge neck tension in order to affect extreme velocity spreads (ES) and harmonics. Furthermore, Lee produce a separate collet style crimping die specifically for this application. The Lee crimp die is not to be confused with traditional seating / crimping dies - though it can be used for the same purposes. In this instance, there is a greater focus on accuracy experimentation when increasing neck tension - changing harmonics with the potential to manipulate sweet spots and also lower ES.

Another form of die is the neck expander die. This type of die is generally used with pistol dies and straight wall rifle (e.g. .45/70) dies to flare the mouth of the case prior to bullet seating. The purpose of this die is simple: to prevent the case

mouth suffering deformation and also to prevent the case mouth shaving copper off the bullet during bullet seating operations. Neck expanding dies are also used during case neck turning operations - discussed in the neck turning section of this book.

Summary of Key Points:

- The three dies we will mainly use include a neck sizing die, a full length sizing die and a bullet seating die.
- The Lee four die set includes a separate collet style bullet crimping die which can be used for further experimentation.

Die brands

While I have not dedicated a full section to press brands, I feel that we need to dissect die brands, as there is much to discuss. I would like to offer my apologies in advance to those of you who are relatively new to handloading and find themselves overwhelmed. All I wish to achieve in this section is an avoidance of traps.

Starting with Hornady - I have had great results with Hornady over the years for hack hunting rifles. But in the precision shooting game I have found that Hornady dies can have limitations. The greatest fault is the use of vastly oversized bodies on both neck sizing and seating dies. While the neck section of a Hornady neck sizing die is generally of good dimensions, the body section is massively oversized. Although the die body should not touch the rest of the case during neck

sizing, a closer fit can help guide cases into alignment with the neck area of the die. Because of this oversized body the Hornady die can be used for a range of chamberings from standard cartridges through to wide magnum cases (which are still a very loose fit), without Hornady having to change tooling which equates to cost savings. The seating die is much the same. Unfortunately this level of play allows a degree of offset to occur during sizing and seating. The result is sometimes poor concentricity and inaccurate ammunition, regardless of a bullet seating collet system. The success of a Hornady die has much to do with the press used, and it must be tested on an individual basis.

A Hornady neck die set with the decapping assembly removed from the neck die. The seating die on the right utilizes a floating bullet guide which can be seen protruding from the bottom of the die. Note, the oval button on the decapper assembly - very useful when necking cases up to form wildcat cartridges.

I try to keep a full range of Hornady dies for the simple reason that the expander buttons are useful for necking cases up or down. I can change 7mm Remington Magnum brass to .338 Winchester Magnum or .30-06 to .35 Whelen. The elongated egg shaped button on the Hornady full length and neck sizing dies is a real boon. The oversized neck sizing and seating dies have also enabled me to play around with some wild and wooly wildcats. So, while Hornady may on the one hand have their share of issues, their tools can be put to great use and problems remedied with additional equipment such as their concentricity tool (discussed further ahead).

Lee is currently the brand I recommend to beginners and advanced shooters alike. And by beginners I don't mean average Joe wanting to hit a paint bucket at 50 yards. With a basic Lee set I can fast track a client to optimum accuracy - without going too far down the technical rabbit hole. If you are starting out (or highly experienced) I thoroughly recommend the Lee Deluxe three die set, which has since become the Lee Ultimate die set and includes a fourth crimping die. These dies will allow you to get started and get on track to extreme accuracy. The beginner can simply follow the instructions that come with the die set and get on with the job, then gradually build further reloading skills.

Lee neck sizing and seating dies have a much closer fit than Hornady. While gathering data for this book I tested the concentricity of handloaded ammunition from several clients and peers as well as studying my own die sets. The so called "cheap" Lee dies produced outstanding concentricity of ammunition to the tune of .003" or less bullet run out, regardless of the experience of the handloader. With care and experience a handloader can stay inside .002" (2 thou). While the Lee RGB (Really Great Buy dies) may be somewhat basic, the deluxe dies are certainly well made.

The Lee Deluxe die set including a full length sizing die, neck die, seating die - along with an appropriate shell holder.

The Lee locking rings feature a rubber O-ring to give the die the ability to float as a means to aid concentricity, another excellent feature. The only complaint I have with Lee dies is the lack of a grub screw to lock the locking ring in place as used by other die makers. Nevertheless, the Lee locking rings can be secured by either fitting another lock ring (e.g. Hornady) over the existing locking ring or drilling and tapping the Lee locking ring to accept a small machine screw (e.g. 6x48 scope base screw). Apart from these options, simply being careful with die fitting and removal from the press can prevent changes of settings. A dab of five minute epoxy can also be used, laid against the top of the ring at its intersection with the threads. However, this is a more permanent solution - not the best if experimenting with a range of bullets. Lee have their own fix - the quick change breech load system. The breech lock collets are made in such a way that they can be locked onto the die body to prevent any loss of settings. Lee also make a second type of breech lock bushing,

called the Eliminator which features a grub screw lock to further secure settings.

The latest system from Lee is a four die set which includes full length sizing, neck sizing, crimping and seating dies. The crimp die is included as an additional means to fine tune accuracy and ES along with its traditional application.

Lee also produce custom neck sizing and seating dies. This service is relatively inexpensive, and after sending a basic fireformed case and new projectile Lee will make very close tolerance dies. The dies are delivered with a very earnest and personal note to the customer. You can’t ask for better service than this.

Lee custom dies.

RCBS standard dies are fairly middle of the road these days. The same can be said of Lyman 7/8x14 dies. My most recently

purchased RCBS dies are slightly out of spec - the neck area of the die is oversized. I am sure RCBS would be willing to replace them if given the opportunity. RCBS now also produce premium neck bushing dies; however, I have yet to use them.

RCBS dies with the decapping assembly removed (center) for inspection.

The now obsolete Simplex company once produced dies that were very similar to RCBS. All of these basic die sets including RCBS, Lyman, Lee RGB and Hornady must be measured on an individual basis. The proof is in the concentricity of the ammunition, and as previously suggested there are tools which can be used to correct concentricity issues.

Redding are possibly the pioneers of the bushing style neck sizing die. This type of die utilizes a floating bushing in the neck area of the die. The handloader can then experiment with various bushing diameters in order to manipulate both accuracy

and velocity deviation. The floating system allows for self-alignment of the case neck within the die to optimize concentricity - and it works. Nevertheless, I do have one issue with these dies: they only size a portion of the case neck.

Redding dies. This set includes a body sizing die which does not size the neck to minimize case distortion, a neck bushing die and a seating die. The floating neck bushing can be seen in the center of the photo. This photo also shows a separate neck expander button (decapper assembly) for optional use.

Norma .300 Weatherby brass sized with a Redding neck bushing die. The die does not size down to the case neck / shoulder junction.

For some reason a number of shooters feel that sizing the entire case neck is of little value and causes unnecessary strain which may affect concentricity. I prefer to have the entire neck sized, especially if bullet jump is long and the bullet is reliant on the case neck to guide it across this freebore area. Some of you may have also heard complaints about short necked cartridges such as the .300 Winchester Magnum, which can again offer less than optimal guidance - more so with lighter weight bullets due to bullet jump. I also prefer the full neck to be sized as a means to obtain low velocity deviation from shot to shot (a low ES). Nevertheless, in my own tests I have found ammunition loaded with Redding bushing dies to be capable of producing extreme accuracy and have so far been lucky with ES. I have not however conducted intensive tests throughout the calibers, so I still have much to learn. My prejudice may be unfounded.

As previously mentioned, Redding also produce a body sizing die and their Type S Full Bushing Die. These dies can be immensely useful in that it is possible to achieve optimum concentricity, where a full length sizing die might otherwise ruin concentricity. A case of being able to have your cake and eat it. Redding are great believers in neck sizing for precision shooting but also understand that from time to time - or in certain rifle configurations - full length sizing can be a necessity. These two types of die attempt to extract maximum accuracy potential by sizing in a step by step manner, attempting to avoid drastic forming operations.

Wilson brand dies are used without a press for the most part. These are called hand dies and are somewhat similar to Lee whack a mole hand dies, the principle being much the same. The neck sizing die is held in one hand, the case is fed into the die, then a mallet is used to whack the case home. The case is then primed and charged, and it is only at the seating stage that a press is used. But again, this step differs from traditional methods. The cartridge is fed into the Wilson seating die, the die and cartridge are then placed under a basic arbor press, and the die is forced down over the cartridge, seating the projectile.

Wilson dies are similar to Redding in that only a portion of the neck is sized. Again, I am not so sure about this system. Wilson dies have been proven in match rifles and typical match chamberings. But I am unsure as to the ramifications of this system if employed in hunting rifles with short necks and long bullet jump along with other idiosyncrasies. On the other hand, having some of the case neck unsized certainly keeps this portion of the neck snug and optimally aligned within the case neck area of the rifle chamber. So again, my prejudice is possibly unfounded. As the saying goes, there is more than one way to skin a cat. I may prefer a long case neck or long bullet as a means to ensure the bullet remains aligned as it travels to and becomes engaged in the rifling, but having the case neck already square to the bore - makes sense, huh.

A final word must go to Forster. I have had simply excellent results from these dies over the years. The Forster neck die is very simple in design, its tolerances are the key. The neck is sized down to an optimal diameter without excessive use of an expander button. In my experience, the process of sizing down and back out again with an expander buttons can really ruin concentricity. By simply addressing basic tolerances Forster have avoided such problems. The Forster seating die is a gem, utilizing a spring loaded collet to guide the case and bullet into the seating die.

A Forster neck die set - simple, practical and highly effective.

Summary of Key Points:

- Neck collet and neck bushing dies offer excellent concentricity.
- Die makers produce a range of options, so be sure to check before purchasing: e.g. Redding neck bushing die versus Redding full bushing die versus Redding traditional generic full length sizing die.
- Current Lee Deluxe / Ultimate dies are an extremely simple, excellent option.

Case trimmers

Ok, so far we have established that we need a basic work area, we are starting with a single stage press and a set of three dies (or four if purchasing a Lee Ultimate set). To this we add a shell holder and we are almost ready to reload.

If you are new to the reloading game, you must understand that **case trimming is critical.** Cases grow during firing - and they keep growing with each firing. After a period of time (sometimes very short) the case will be so long that the neck protrudes into the bore (freebore), vying for the same position as the bullet. Once we close the bolt, the case mouth is then crushed against the bullet, trapping it in place. The chamber becomes a crimping die. Obviously if the cartridge is fired pressures will be extremely high and potentially dangerous. It’s like long haired hippies and angle grinders - something’s gotta give.

As a side note, the same pinching can occur if carbon becomes caked in the neck area of the rifle chamber. This topic is covered in my third book.

The most basic of case trimmers is the Lee system; this is an excellent starting point for the handloader. The Lee system consists of a shell holder, which can be driven in a cordless drill, and a cutter. Pilots are sold separately, the pilot being of the correct width and length for your cartridge.

The Lee trimming system. At left is a pilot and shell holder (sold together). The pilot and shell holder must be correct for your cartridge. The pilot and shell holder in this photo are for a .308 Winchester. On the right is a Lee cutter and lock stud. These are also sold together and can be used with the full range of Lee pilots and shell holders.

The Lee trimming system shown with .308 Winchester case.

Cases must be sized first to both remove the primer and obtain the correct neck diameter for the pilot as a means to prevent the case flopping around which could distort the case neck. The fit of the case neck over the cutter needs to be neither too tight, nor too loose. Generally you will find that the fit is very tight, sometimes to the point that it may stress the case neck. If your pilot is too tight, I suggest placing the pilot in a cordless drill and sanding it down to a smooth fit.

Bench mounted case trimming systems are also very common. These are especially useful when dealing with wildcat cartridges, allowing the end user to customize the trim length.

In more recent years motorized systems have hit the market. These cannot be called automated as they are still labor

intensive, but they do speed up the process. Hornady produce one of the better units which they call the Case Prep Center. This takes care of trimming, chamfering, primer pocket cleaning as well as giving the inside of the case neck a clean up. The end user can adjust the length of trimming to suit both standard cartridges and home grown wildcats. The Hornady system takes a bit to set up, but for large volume users it can be easier on the hands than the Lee system, especially as we get older.

Maximum allowable case lengths and suggested trim lengths can be found throughout various sources both on and offline. Lee dies generally come with the maximum length included in the instructions. Lyman make a simple tool called the E-Zee Case Gauge which shows the maximum allowable lengths for a vast range of cartridges. This is a very handy tool for the beginner. If no information can be found and you are working with new or once fired brass, you should consider this the maximum case length, write down this figure, then trim cases back .010” or .3mm. I do not recommend trimming any shorter than this, as the chamber of your rifle may be longer than standard. Furthermore, if you are a metric user the figure I have given of .3mm is ample, as I have rounded this up from .254mm which is the traditional trim length; a measurement which for many handloaders is difficult to obtain accurately.

If you are using a Lee pilot and you find that it does not trim the cases to an ideal length, the tip of the pilot can easily be sanded back to reduce length. However, be careful when sanding as this can reduce the pilot length very quickly and it is easy to go too far. If you are shooting a wildcat for which no Lee pilot is made, use either a short pilot of the same caliber and adopt a “trim and check” operation or use a bench mounted adjustable trimming system.

In practice, after neck sizing or full length sizing your brass you must run your cases through a Vernier caliper, set and locked to your maximum allowable case length. Alternatively, the cases can be passed through an E-Zee gauge. Those that will not pass through the gap must be trimmed to size. It is up to you whether you try to keep your entire batch of ammunition the same length or whether you have some cases at minimum and others at maximum length. If you are a beginner please do not worry about getting every case exactly the same length. More advanced users with time to burn may wish to explore any differences in accuracy or ES. Personally, I do not get too carried away with this.

Some of you will on occasion hear talk of matching your maximum case length to the actual chamber of the rifle rather than basing the maximum length on an industry standard figure. This is another advanced step which may be pursued at leisure and is not to be considered critical. The method for this involves cutting a case neck in half and trimming the now shortened case square, then seating a boat tail bullet backward in the now short necked case. The offcut is then cleaned up to make it as square as possible and mounted over the projectile, essentially creating a case and bullet with a gap in its neck. The cartridge is then chambered, the offcut pushing back to determine the maximum case length. A figure of .010” should be removed from the determined figure and recorded as the maximum allowable case length. It’s a tricky affair at best. Still, advanced users may find this process rewarding as some rifle chambers may be up to .030” or .762mm longer (sometimes more) than standard. The extra case length can be used to guide bullets squarely into the bore. But again, please do not consider this a critical factor. Accurate ammunition can be made by sticking to the basics.

Note the neck area on this chamber cut-away. The small gap in front of the case neck is critical. If the neck is allowed to grow further forwards it may become pinched, effectively crimping the bullet in place and causing dangerous pressures.

Summary of Key Points:

- Case trimming is critical for safety.
- Find your maximum allowable case length from reloading manuals or websites (including ours).
- If no information can be found on maximum allowable case lengths, consider new brass as being maximum length.
- Lee trimming system is simple and highly

effective.

- Automated systems can be a bit easier on the hands, especially during bulk operations.

Case chamfering tools

After trimming, your cases will need to be chamfered inside and out to remove brass burrs. There are many competing tools for this. My current preference is the Lyman chamfer tool - a very simple affair. I used Lee for many years and cannot really fault that either.

It is important to trim the case in such a way that the inside of the case has more chamfer than the outside. If both are brought to a knife edge point or the outside chamfer is greater than the inside, copper will be shaved from the bullet during seating operations. If the bullet is being shaved, you need to either adjust your chamfer or dull off the final chamfer with polishing.

A light chamfer on the outside and a heavier chamfer on the inside of the case neck - all the while avoiding the creation of a knife sharp edge. Poor chamfer angles are a common mistake.

Once the case is chamfered, the mouth of the case should be polished to dull off the final edge. I use a tool which I have not seen others use, but if you have access to an engineers supply store I suggest you keep an eye out for it, as this tool can be handy. The tool (actually a tool head) is a white mounted point. These are made by Norton and Pferd as well as others and are a type of fine grinding stone for end grinders. The shaft diameter should be ¼ or 6mm. The case can be spun on a cordless drill and the tool head basically pushed into the case mouth. I follow on from this with a quick lick of a maroon Scotchbrite poly pad (or maroon Norton Bear-Tex pad), polishing the outer case neck or entire case at the same time.

The case is mounted in a drill, using the lee lock stud (Lee trimming system). On the left is a white mounted point while on the right is the excellent Lyman chamfer tool. Cases are finished with a polypad (top center).

The white mounted point is not critical, but a poly pad is highly effective. At the very least I would like you to use a 3M kitchen grade green Scotchbrite pad to dull off sharp case mouth edges and then lightly polish the case neck or body. The finer grade maroon pad is more gentle on the case body but a green pad will suffice.

Summary of Key Points:

- Case chamfering critical to remove heavy burrs.

- Chamfer both inside and outside the case mouth.
- More chamfer on the inside than the outside.
- Chamfer angles can have a profound effect on accuracy. A good angle will prevent the case mouth shaving copper from the bullet.
- Dull off sharp case mouth edge with poly pad etc.

Primer Pocket and flash hole tools

For consistent ignition of the powder charge the primer pocket of the case needs to be clean and free of obstructions.

It is important to understand that there is a difference between cleaning a primer pocket (removing carbon) and actually uniforming the pocket which involves cutting the pocket to a set (consistent) depth. A primer pocket uniforming tool consists of a cutting face and also a stopper, establishing a set depth. In contrast to this, primer pocket "cleaners" generally may have a coarse file type face, a wire brush, or scraping face, but no stopper to set the depth.

The cutting blades of a primer pocket uniformer can be used to clean primer pockets. The only trouble with this method is that the ongoing practice of cleaning primer pockets with the uniformer will dull off the cutting blade edges. This is not so bad if the pocket uniformer is relatively inexpensive, but with high end kit it pays to have a dedicated primer pocket uniformer and

a separate primer pocket cleaner (or a cheap primer pocket uniformer used for cleaning.

Lyman make both a primer pocket uniformer (cutter) and a primer pocket cleaner. Both are good ergonomic designs and are highly recommended.

Lee do not make a uniformer and instead offer a basic primer pocket cleaner, the cleaning face looking much like a flat head screw driver tip. RCBS differ again with a wire brush type primer pocket cleaner.

The Hornady Lock N Load Case Prep Center features a good example of a file faced primer pocket cleaner without a depth stop.

Primer pocket cleaner featured on the Hornady Case Prep Center. A basic file shaped tool for primer pocket cleaning rather than uniforming. This one will soon need replacing due to wear.

Ok, so now it is confession time for me. I generally use a Lyman primer pocket uniformer to both uniform and clean primer pockets in a generalized manner. Such a rebel. Unfortunately this means that the tool suffers a good deal of unnecessary wear when cutting carbon and needs to be replaced more regularly than otherwise. Having said this, I currently use a K&M primer pocket uniformer as my dedicated uniforming tool for extreme accuracy work. I treat this tool with the utmost care. I use the K&M tool on new brass to set pockets to a consistent depth. After this I use the Lyman uniforming tool.

A Lyman primer pocket uniformer along with a K&M primer pocket uniformer (left). The K&M tool is a more expensive piece of kit and is best used for uniforming only, rather than cleaning (removing carbon deposits) which can be performed with the Lyman, though the latter is also not designed for such purposes.

A flash hole deburring and uniforming tool works as its name suggests. Many brass cases have the flash holes punched rather than drilled during production. The trouble with this method is that a part of the punching can remain attached to the inner edge of the primer pocket, partially blocking the flash hole. Generally speaking this type of burr will eventually erode away, but it is good to have a tool that can properly deburr and uniform the flash hole. This job only has to be performed once.

K&M flash hole uniformer. The brass bushing floats, allowing the one tool to be used across a wide range of cartridges.

My thoughts on the priority of purchasing are these: If you want to get into basic reloading, a basic primer pocket cleaner is a must. Or you can cheat like me and use a Lyman uniformer for both basic uniforming and cutting, but be aware that the tool will become blunt after a period of time when used in this manner. If you want to get into precision reloading and shooting you will need to have some form of separate tooling - a dedicated primer pocket uniformer and a secondary tool for primer pocket cleaning. A flash hole uniforming / deburring tool completes the set.

Summary of Key Points:

- Primer pocket cleaning differs from primer pocket uniforming.
- Both primer pocket cleaning and uniforming can be used to help achieve consistent ignition.
- Flash hole deburring can be used to help achieve consistent ignition.
- Consistent ignition can help lower ES.

Case tumblers and sonic cleaners

A final step that many handloaders perform is case tumbling or sonic cleaning. These are employed to clean both the outside of the case along with the inside that is otherwise difficult to reach.

If you are a low volume shooter, there is no great need for case tumbling or sonic cleaning. If for example you are handloading for only one or a few rifles and have purchased a pack of fifty cases for each, you will find it relatively easy to look after the cases with a light exterior polish. The cases will generally be worn out before carbon build up inside the case has any major negative effect.

If you are a high volume shooter or own many rifles, you may find that brass care becomes quite a chore. In other cases a handloader may pick up a large quantity of used brass that exhibits minor corrosion and needs to be cleaned before inspection and storage for future use. Second hand, once fired

brass may have been stored in a dusty bucket or who knows what. A case tumbler or sonic cleaner can be very handy in these examples, not just for cleaning but also for safety and bore preservation should there be any abrasive dirt residues inside cases. That said, it is important to remove tumbler media residues or sonic cleaning moisture residues prior to any further handloading operations, as these can also cause problems.

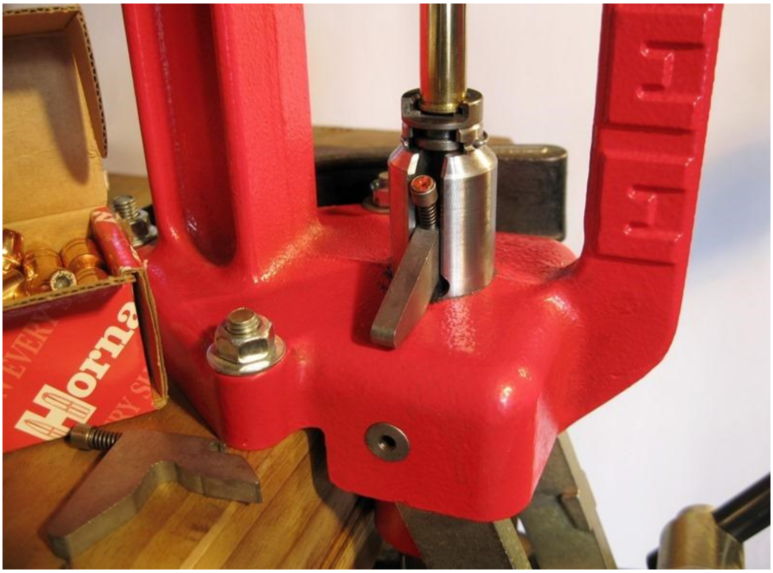
A further advantage of case tumbling is that it removes any need to use a poly pad to dull off a sharp edge created during the chamfering process. Both tumbling and sonic cleaning are a good means to minimize case corrosion (carbon attracts moisture) when storing cases for long periods.

Summary of Key Points:

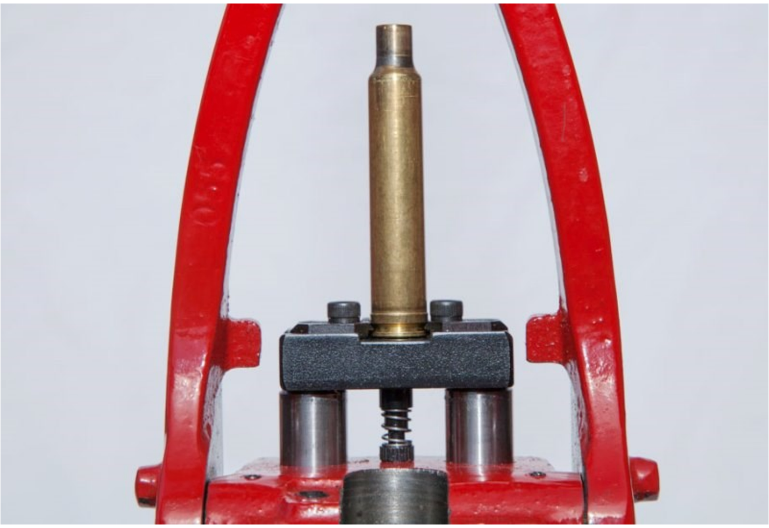
- Case tumbling / sonic cleaning not normally critical unless cases are contaminated.
- Case tumbling / sonic cleaning very useful for high volume users and also recovery (and inspection) of older or second hand brass.

Priming tools

Once the cases are finally prepared we need to set about priming them. Most presses come with an inbuilt priming system, so there is little need to buy extra equipment if you are on a limited budget. Nevertheless, there are factors that deserve consideration.



Lee and Hornady utilize similar press priming systems. In this photo I am using large primers (.444 Marlin). Beside the press sits a small small primer seater for cartridges which utilize small primers.



Forster Co-Ax press priming system.

A separate hand tool can be very useful as a means to gain a better “feel” for how much pressure is applied when seating primers. As a result it is possible to gain somewhat greater consistency from cartridge to cartridge. Those who use a press ram can however achieve the same level of feel with practice. This said, I believe that the hand priming tool offers one significant advantage - speed.

The tray fed lee Ergo Prime.

I currently use a K&M primer seating tool but am equally happy to use my press. I originally used a Lee hand tool that used to come with Lee whack a mole target shooting die sets. This looked much the same as the current K&M unit. I have used the Lee Ergo Prime tray fed unit with success, however the plastic tray perished very quickly and soon fell to pieces. The K&M does not have the same speed as a tray fed tool but it is extremely solid and designed to produce optimum consistency.

Both the Lee and K&M priming tools utilize Lee priming shell holders. It is therefore important to make sure you have the correct shell holder if using one of these hand priming systems.

K&M priming tool with a set of Lee shell holders.

Summary of Key Points:

- Hand priming tools useful to obtain a consistent feel when seating primers.
- Hand priming systems can be very fast.

Scales

A scale is required to weigh powder charges. The scale is a critical item and needs to be capable of delivering extremely accurate powder charges when developing handloads. Today we have two types of scales to choose from: the traditional balance beam scales and digital scales.

I think scales have to be one of the most difficult issues we are faced with when shopping for reloading kit. Quality is not what it used to be, and to a large extent digital units have not really solved this problem.

In my research over the years, I have found Lee balance beam scales to be the most accurate of all scales. The problem is, these units are very slow due to the lack of a magnetic dampener which other manufacturers utilize as a means to help handloaders speed the process of powder measuring. The Lee scales are so slow as to cause Tourette's syndrome. Don't believe me? Ask your wife or a friend to load 20 cartridges with Lee balance beam scales and see what happens. And yet, these are perhaps the most consistent scales on the market. The Lee scales are also the cheapest balance beam unit and are accurately calibrated. My suggestion is: If you have any doubt as to the quality of your scales, Lee scales can be purchased and used as a fallback or calibration unit (even if you do not use these as your main powder weighing tool).

The extremely accurate Lee balance beam scales along with a Frankford arsenal powder trickler to help speed up the settling process.

Other balance beam scales made by various brands such as RCBS and Lyman all come from the same manufacturer - Ohaus. This was once a prestigious company. I say once because the modern units are very much hit and miss.

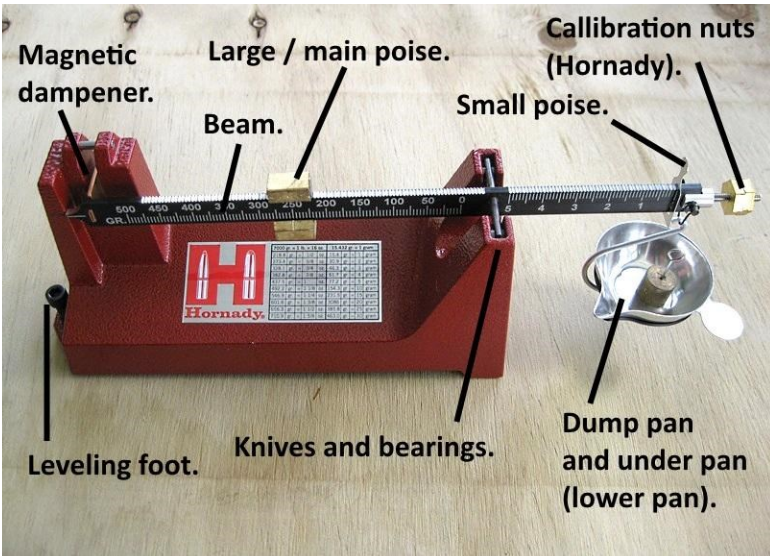
I am a firm believer in balance beam scales. I think that digital scales should be treated as a secondary item.

I started out with a very old but good set of RCBS (Ohaus) scales which I eventually wore out through rough usage. I then moved to an old set of Lyman scales (Ohaus) which were again very good. Right up to the moment a few years ago, when they took a fatal hit as an object fell onto them. After this I purchased a new set of RCBS scales - the best money could buy. These would not hold zero and had to be sent back. Following this I went with Redding - the worst scales I have ever owned. Again, they would not hold zero. Those went for flying lessons. I took more pleasure from this than the potential refund.

I am currently using Dillon (Ohaus) scales along with Hornady scales and these have been very good. A friend of mine went shopping for Dillon recently. He came home with the same set as mine; they would not hold zero. He took them back, bought another brand of balance beam Ohaus scales; they would not hold zero. He finally found yet another set of Dillon scales (the same design as the first) and set them up in the shop: eyes burning holes into their body, sparks flying, visions of the scales being placed on the clay bird thrower across the aisle and launched across town. But ultimately, these scales proved to be top notch. So, what is that - a one in three chance? If we can learn anything from this, it is that balance beam scales must be treated on an individual basis and we need to be vigilant as to quality.

Dillon balance beam scales. These are generic Ohaus scales.

After many years without balance beam scales and perhaps due to complaints over digital units Hornady are back in the game with a set of U.S. produced scales that work well and hold their zero. These are based on a home grown design Hornady previously utilized with great success. At this time of writing and from what I have seen so far during my own testing I would put these scales to the top of our reloading kit shopping list.



Hornady balance beam scales along with basic scales terminology.

Digital scales shopping can be just as much fun as shopping for balance beam scales, but rather than an Ohaus label somewhere on the unit you have a “Made in China” sticker. Though I do not wish to offend any Chinese folk who take great pride in their workmanship. The trouble is more to do with mass production, budget materials and low wages - never a good mix

if we are looking for a precision tool. The scales are shifted from China to the west and depending on who's secondary label gets slapped on the scales, they may be sold for $5 or $100. Most (regardless of the price tag) maintain a degree of accuracy and for what they are, are very good. But when it comes to very small units of weight, these scales can have great difficulty with accuracy and consistency.

Laboratory grade digital scales are very accurate. Precious metal scales are also accurate. But fully tested and approved scales of these types are very expensive. Prices generally sit around $1000 and it is only recently that we are seeing cheaper units. These cheaper units may well be made in China but are built to higher than typical standards. There are many handloaders who utilize laboratory grade scales to remove potential errors. If you wish to find out more about such scales, you will need to find a company that specializes solely in weighing equipment. These companies must adhere to strict guidelines to meet various industry and government regulations.

Of the reloading company brands RCBS have tried to lead the way, offering good digital scales which are also built into their powder dispensing unit (discussed ahead). But generally speaking I would prefer those who are new to handloading to refrain from using digital scales or at the very least use balance beam scales to monitor the accuracy of digital scales. As you gain experience you can move towards high end digital scales or an automated system if you prefer.

The one thing I find frustrating with digital scales is that they will turn off during use if left unattended for a moment too long. There is also the potential for user error, if the scales are set to zero and the handloader weighs each charge up to a

given weight. For example, let's say the powder charge is supposed to be 44.6 grains. A lapse in concentration may lead to a charge weight of perhaps 46.4 grains, the handloader neglecting to see the error. To avoid this, the first charge should be weighed out and upon reaching the desired charge the tare button should be pressed. The scales will then read zero once they hit our 44.6 grains example, rather than weighing from zero up to 44.6 grains.

When using either analog or digital scales, the units must be set up in an area with no breeze. It has been said that digital scales are more sensitive to breezes but I find that both types suffer. That said, digital scales do sometimes appear to be more sensitive and at times frustrating, as it seems that breathing in the wrong direction can cause problems. If you are weighing charges at your rifle range, I suggest weighing them in a vehicle or fully enclosed shelter of some sort.

Summary of Key Points:

- Not all scales are accurate, be careful when shopping.
- Scales shopping can be worse than shoe shopping with your wife.
- Balance beam scales tend to be more accurate and reliable than typical digital scales.
- Balance beam scales recommended for beginners. Hornady very good at this time of writing.
- RCBS currently making generally accurate digital

scales as a part of their automated system.

- Laboratory grade digital scales are the most accurate (of digital type) but can be extremely expensive.
- While slow, the Lee balance beam scales can be used as either the main scales or as highly accurate test / back up scales.
- Use away from breezes.

Testing and caring for your scales

I will relate a story here to emphasize how important it is to have your scales properly calibrated. A gunsmith friend of mine had put together a rifle for a client and then developed loads - it was a sweet shooter. The client then took possession of the rifle and set about duplicating the suggested load. What he did not know was that his scales were reading low by five grains. Now, had he been following a reloading manual and started with suggested start loads, this level of error would have most likely seen him hit maximum but safe pressures. But in this instance the load was just above book maximum. The client then dumped another five grains on top of this. Fortunately the action held - but it was very close to complete failure. This is an obvious example as to why powder manufacturers need to be very careful when recommending powder charges.

With balance beam scales the general method of obtaining the correct tare (zero) weight is to employ lead shot in a container below the pan. The optimum weight of lead shot under the pan should be such, that when the scales are set on a level bench

and the adjustable leveling foot of the scales is set so that the body of the scales is level, the pan should zero. If there is too much shot in the pan, the leveling foot must be jacked up to zero the scales. Too little shot and the leveling foot must be lowered to zero the scales. Very rarely scales will either have so much or so little shot in the pan that they end up being canted when zeroed. If the cant is too heavy, there is a risk that the V shaped knife blades of the scales will sit back on the V shaped bearings rather than being centered. This may interfere with measuring and readings. In these cases it can be better to add or remove shot from the pan, rather than jacking the leveling foot up or down.

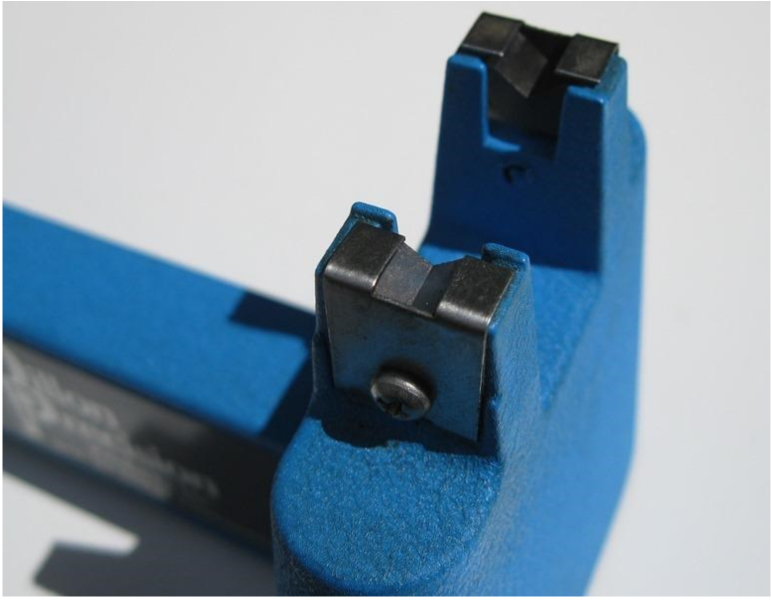
Lead shot is used to tare Ohaus balance beam scales.

All we have discussed so far is the zeroing of our scales - essentially getting the zero mark on the beam to match up to

the zero mark on the body of the scales while keeping the scales relatively level. This has nothing to do with testing the scales for accuracy of weight readings.

To calibrate scales for accuracy we need some kind of a test weight. These can be purchased from Lyman or specialized weighing equipment companies (or perhaps borrowed from a friend). A less exact but acceptable practice is to test a handful of match style bullets. A good quality match bullet may still have a level of weight discrepancy but it will get you to within a ballpark figure without the same dangers as initially described.

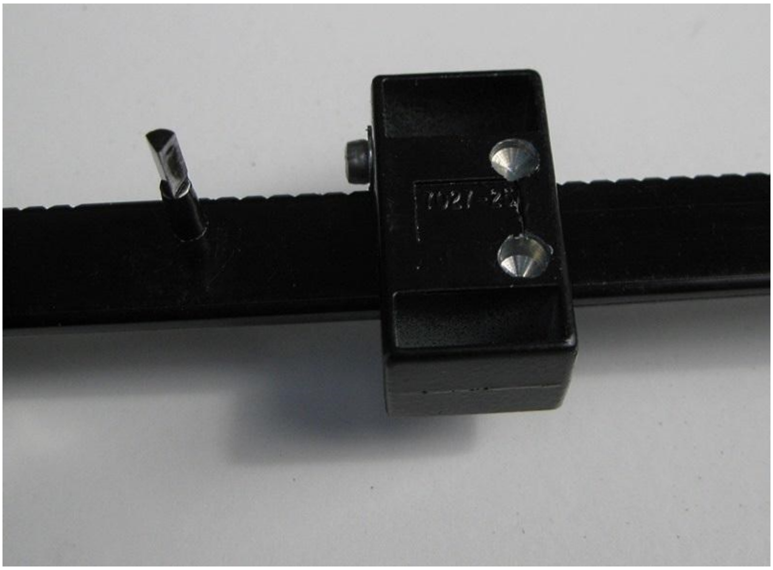
To begin the process set the scales on your workbench, ensuring there are no drafts. Check that the bearings are moving freely by pushing the beam away from you and then towards you and then back to the rear of the body. I prefer to have the beam pushed to the back of the scales as a reference point, as I find that scales often produce different readings depending on where the blades sit within the bearings.



Glass bearings of the Dillon / Ohaus scales.

Set the weights on the balance beam to zero and then level the scales, using the dial wheel on the foot of the scales. The zero line on the body needs to be aligned to the line on the balance beam. Spinning the dial will allow you to fine tune the zero. Next, remove and replace the pan a few times to be sure you have obtained absolute zero. I also like to keep my scales swinging slightly as a means to ensure the balance beam knives are moving freely on the bearings. We can now set about testing the scales. Let’s say that your chosen bullet has an advertised weight of 180gr. Take several projectiles from the pack and weigh each one to determine the general weight range. If your scales read a variation of around .2 grains with 180 grains being an average, you can leave the scales alone. But if the scales are showing a very large error, then you may need to add or remove weight from the main poise (the heavy weight

that sits on the balance beam). Weight can be removed by drilling the poise; weight can be added by applying epoxy to the poise.



In this photo we can see one of the blades of the balance beam (left) and the poise. Note the holes drilled in the poise during final calibration at Ohaus.

A final and very important test is to make sure that the scales hold zero. To perform this check take a teaspoon of powder and weigh out a sample charge of for example 50 grains. Next, remove and then replace the pan. Remove and replace the pan several times. Did the beam return to zero or is it now reading off zero? Try swinging the pan to see if this is a key factor. If the scales then hold zero you will know that you need to swing the pan with each charge. Did the position of the blades (center of beam pushed to rear of scales) affect repeatability?

If the scales simply won’t hold zero, they need to be replaced.

These are very important areas to study when setting up your scales, so please take the time to check their accuracy and ability to return to zero.

The maintenance of balance beam scales is for the most part very simple but also a critical factor if the scales are to remain accurate. In past years I have used a very light protective lubricant to prevent rust forming on beam blades but this poses problems. Even the lightest oil based lubes eventually become slightly tacky after attracting dust, effecting readings. Lube can also run in behind the bearings and cause the beam to appear “sticky” rather than free moving, also effecting readings. My current method is to simply use powdered graphite as a lubricant. The beam blades can be treated with a dry protective coating (eg car polishing wax) for rust prevention.

Occasionally I remove the stainless covers which house the glass bearings and remove the bearings. I take note of their orientation, so that they can be put back together in the same order. I clean the bearings and housing with cotton buds and a degreaser. Once they are dry I dip a cotton bud in graphite, then run this throughout the housings, then over the bearings and then remove any surplus graphite. Following this the scales can be reassembled. The beam blades also get the graphite cotton bud treatment. It is important to understand that scales are delicate, so only perform such operations when you have a good patch of quiet uninterrupted time on your hands, allowing you to work patiently and carefully on maintenance.

If the balance beam blades become rusty, rust removal must be performed with the utmost care, utilizing minimal abrasion. I thoroughly recommend the use of a magnifying glass for careful

viewing of the blade edge. If the blade edge is damaged in any way, re-sharpening can be performed with a flat Ezi-Lap fine diamond honing stick. Having said this, it is all too easy to get the sharpening angles wrong with such a small surface area that is so hard to view. Therefore sharpening must be performed with the utmost care, utilizing minimal passes while rechecking the blade with a magnifying glass regularly. If the blade angles are destroyed, the beam will need replacing. Some reloading manufacturers offer replacement parts, others do not.

Please also note that the blades on a balance beam are in essence a press fit pin. The blades are not welded to the balance beam in any way. If the scales are treated harshly, the press fit of the pin (blades) can become loose and the pin can rotate within the beam, taking the blade's V edge out of alignment with the V block shaped bearings. It's all downhill once this happens. Blade alignment is a critical factor in the accuracy and repeatability of scales. Misalignment can occur either during manufacturing or through wear / accidents thereafter.

The Hornady balance beam scales differ somewhat from the Ohaus type, so I would like to make a few comments on this for those using or contemplating to use these. The Hornady scales do not have shot under their pan, the tare weight is pre-set. Calibration is achieved via two brass nuts on the beam which act as adjustable counterweights. This differs from the Ohaus type scales which require manufacturing staff (or end users as described earlier) to drill the main poise in order to achieve weight calibration. The Hornady scales do not have glass bearings and instead have steel bars for the beam blades to rest on. The steel bars and beam blades need to be kept corrosion free and again lubricated with graphite. I have not sat on an

assembly line and tested every unit. I only have experience with my personal Hornady scales and the comments of a few other users, but so far I have found this to be a generally wonderful little unit to work with. I have lost a few minutes here and there staring at it, thinking about what a nice piece of kit it is and have told it so once or twice as well. I hope it was listening.

Digital scales are certainly easier to set up than balance beam scales. We simply turn them on, hit zero, wait for the scales to settle, then place the pan on them, wait some more and then hit the tare button. But again, I suggest taking either a properly calibrated test weight or match bullet and performing a check. If the scales show a large degree of error, they need to be replaced.

Scales, whether balance beam or digital are very delicate. It is extremely important to store them in such a way that boxes of projectiles cannot be dropped onto them (the voice of the guilty here!). All bumps and knocks are to be avoided, as the (seemingly) smallest bump can sometimes upset them. Keeping scales dust free is also very important. The less maintenance (within reason) we have to perform on our scales the lower the intrusion to the unit. Dust accumulation in the bearing housings can make scales less responsive (sticky) and can necessitate more intrusive maintenance as previously described. So, if possible try to find some means of covering or shelving the scales, but in such a way that bumps can be avoided. Even a soft cloth draped over them can be useful.

As a last note, the calibration of scales is also immensely important with regards to consistency of loads in the event that scales become damaged and are replaced. Your current unit may differ in calibration from its replacement. If the scales differ

greatly, there may be safety concerns with regard to cartridge load pressures. Even if the scales differ only by a small amount such as .2 grains and your rifle or rifles are sensitive to load changes of .2 grains, loads may need to be re-tested and accuracy sweet spots re-explored following the replacement. I therefore suggest that you do your very best to calibrate your scales to read true. If they have a small but acceptable error when using an accurate test weight, record this error at the back of your journal for future reference, should the scales become damaged.

Summary of Key Points:

- Accuracy of scales is critical to safety.
- Find a suitably accurate test weight to test and calibrate scales.
- Keep blades corrosion free.
- Keep blades and bearings lubricated with a dry lube.
- Record any small errors in the back of your journal.
- Keep scales protected from bumps. Think delicate.

Powder dispensers and tricklers

Powder dispensers have been with us for decades now. The basic premise is a hopper system which allows us to throw charges in order to greatly speed up the process of reloading.

A beginner does not need a powder dispenser when working up batches of 20 to 40 rounds for a weekend shoot. But as time passes and the need for more ammunition arises, a powder dispensing system can be very useful.

The basic manual powder dispensing systems each have their strengths and weaknesses. Charge weight errors can be common, depending on the type of powder and the hand technique used when throwing charges. Errors may be up to 1 grain or higher. If we were to pick a mid-point load from a reloading manual and throw charges without weighing each one, we could rely on such a unit when loading for a woods / bush rifle. But when loading for a precision rifle this basic hopper simply lacks accuracy. Nevertheless, a charge can be thrown light, dispensed into the scales pan, and following this a powder trickler or tea spoon can be used to bring the charge up to its final weight. Used this way, a basic unit like the Lee can be very good, speeding up the reloading process.

A trickler does exactly as its name suggests, dispensing a very small stream of powder. The trickler is filled with powder and placed beside the reloading pan of the scales. This method helps prevent the frustration of manually dispensing too much powder with a teaspoon and then going through the “dig it out again” which is a great way to lose time. A trickler is especially handy when working with the sensitive Lee scales.

I do not use a trickler myself, mostly because after many years I have quite a feel for manual powder dispensing with a light weight plastic tea spoon. Nevertheless, many of you will find a trickler to be a handy item when reloading.

Hornady's Lock-N-Load manual dispenser which features interchangeable inserts is one of the more comprehensive powder dispensing units. This is a very handy system, as it can take quite a bit of fiddling to set charge weights in traditional units - even if aiming low. Hornady have tried their best to make this dispenser as accurate as possible, so that it can be used with their Lock-N-Load progressive press without the operator having to check each charge weight. But as always accuracy depends on the powder type used, and a degree of error is generally present regardless of efforts to ensure otherwise. Still, this dispenser can be used to make relatively accurate and sometimes very accurate ammunition for general hunting. A common practice is to weigh a powder charge about every five rounds, or sometimes at a lower frequency if making bulk ammunition. But for those who wish to shoot precision rifles, especially at extended ranges where a low ES is a critical factor, all charges should be checked on scales.

Fully automated powder dispensing systems can be extremely useful. These units include a dispenser with trickle feature, dropping charges into a pan on built-in scales. Each charge is weighed rather than dispensed based on volume. These systems are not as fast as a traditional hopper which works about as fast as the operator can lift and drop a 3" handle, but they can be vastly more accurate.

Early automated systems were not so sharp, occasionally trickling too little or too much powder before coming to a final

stop, but current units tend to display greater accuracy. The RCBS Charge Master is possibly the best of the brands, trickling to within 1/10 of a grain. But again, some RCBS units are better than others, and sometimes a few kernels of powder must be added or removed to achieve the desired weight. Regardless, a high volume precision shooter can make good use of the RCBS unit.

Summary of Key Points:

- Powder dispensers are not critical.
- Powder dispensers can be very useful for high volume operations - a great time saver.
- Tricklers are not critical but can be very useful for final top up dispensing.

Powder funnel

This is a most basic item which hardly seems in need of a description, and yet it is a critical item. A powder funnel is used when pouring powder into the cartridge case. With the advent of short magnums, many of the funnels of old can have problems when used with these case designs. In essence, the funnel should sit over the case mouth in such a way that no powder can escape during pouring - avoiding the frustration of having to re-weigh charges. It is also easy to miss a few kernels of powder slipping through a gap, if we are not fully focused on this. So, we need a foolproof funnel to prevent such occurrences in order to ensure we are making accurate ammunition. Your funnel may flop around a bit, but as long as it

covers the case mouth and does not allow any spillage, all is well.

A full funnel kit can include apertures to deal with large and small cases as well as a drop tube. A drop tube is a relatively naughty piece of kit. We can sometimes use this to achieve maximum velocities in longer barreled rifles when using a powder which would normally be too slow and bulky for our cartridge. Feeding this type of powder through a drop tube can help pack the powder down into a smaller area. With this technique, we can sometimes fit enough powder into the case to reach higher than normal velocities without powder compression or excessive pressure. A perfect example of this is using slow burning powder in the .30-06 Ackley Improved to drive 180 grain bullets at velocities approaching that of the magnums. Another example is the Hornady Light Magnum factory ammunition produced prior to Hornady’s adoption of their current high energy powders.

A drop tube is not a necessity but it can make for a fun tool to experiment with, if this item is discovered in a funnel kit.

MTM funnel kit.

Summary of Key Points:

- A powder funnel is critical to prevent spillage.
- The funnel aperture must match the case design.
- Drop tubes can be fun.

Case sizing lubricants

Case lube is used during full length sizing and some neck sizing operations. The exception to the requirement of lubrication is when using carbide dies or Lee's current neck die system. Regardless, it still pays to have lubricant on hand for standard dies and other tasks for which these products may be useful.

A critical factor is that the lubricant must be made from ingredients that will not contaminate powder and cause either instant or gradual degradation of the powder or primer, which in turn may lead to dangerous conditions.

Lubricants can be divided into two types: wet and dry. Wet types are either wax or oil based and are used for full length sizing operations. Personally, I am not a great fan of petroleum based lubes, as these may cause powder contamination if surplus lube remains just below the inner case neck where it sometimes hides after sizing operations. Short term, this may not be a problem; my concern is more towards ammunition stored for an extended period. I therefore recommend a wax based lubricant, and for many years I have used Lee.

Lee wax lubricant alongside a tub of graphite and steel shot (to prevent clumping inside case necks). Dry graphite lubricant can be used for neck sizing operations.

Wet lubricants are available in paste, hard wax, aerosol and pump spray form. Both, the pump and aerosol sprays can be great time savers; however, I have to admit that I still prefer the traditional Lee paste. I do not like spraying any product inside the case, as happens when a pump or aerosol is held at 30 to 45 degrees. The downside of the product I use is that it can be somewhat messy, gumming up dies and leaving residues on case bodies.

A lube pad is the standard means of applying lube. Lube is applied to the pad, the case is then rolled across the pad. The case neck is lubed with the fingertips. Great care must be taken not to lube the shoulder as this may result in dented cases which then need to be put aside and fireformed. Personally, I do not use a pad. I simply pick up a pinch of lube and rub my thumb, index and middle finger together. I hold the case by the neck with my left hand and spiral the case through the three fingertips, avoiding the shoulder. The case is then turned, allowing me to lube the outer case neck. After this the cases are placed in a tray and the inner necks lubricated with paste on a cotton bud.

Lubing the body of a case with Lee wax in preparation for full length sizing.

After the case body is lubed I flip the case and lube the neck.

The final step is to lube inside the case neck.

After full length sizing the cases, the case body must be cleaned thoroughly, the inner case neck swabbed with a clean cotton bud. High volume shooters may prefer to use a case tumbler at this point in the process. The die also needs to be cleaned, as a water based wax lube can cause rusting of the die if the die is put away before it is fully dry.

A simple alternative to my system is to lay cases on their side in a box, then spray the cases with a basic pump or spray lube (or cooking oil), rolling the cases to ensure full coverage. The light coverage of a fine lubricant will ensure no case shoulders are collapsed. This method works fine, provided there is no risk of the spray entering the case mouth and that there is no heavy build up which may later enter the primer pocket.

The final step before sizing is to lubricate the inner case neck and for this I recommend a traditional wax paste applied accurately with a cotton bud. After full sizing the inner case necks can be swabbed clean with another cotton bud.

My traditional method is simply that - traditional. And as I read my own words here, my ignorance towards the adoption of alternatives becomes obvious. As long as the inner case and primer pocket are kept free of oils, there are many ways we can skin this cat. While testing for this book, I found that Armor-All (water based with lanolin / plastic protectant) could be used as a case lube provided sizing operations were not severe. Armor-All also contains silicone but this should not be considered an aid. Silicone cannot handle high pressures.

Dry lubricants are used for neck sizing operations only. The simple fact is, a dry lube cannot handle full length sizing operations. Dry lubes can be based on moly, mica or graphite. I use graphite which I place in a container with steel shot. The

shot helps prevent caking. This system is also utilized by Redding who produce Imperial Dry Neck Lube - an excellent neck sizing lubricant.

When using a dry lube the case is dipped in the lube, ensuring the inner and outer neck are well lubricated. The case is then run through the neck die and following this, given a simple wipe clean. Few folk clean the inner case neck which means surplus dry lube can end up becoming a light bullet lubricant of sorts, much like moly bullet coatings. I tend to leave this be unless the bore is a very low fouler or of a poor dimension, so that it needs all the fouling it can get.

If a case lubricant is not utilized in standard non carbide full length sizing dies, the case will become stuck in the die and is sometimes near impossible to remove without damage to the die. Application methods are equally important. If we use only a small amount of lubricant, the case may become stuck. If we use too much lubricant, we may cause case dents. Though this is only a minor inconvenience, as dented cases can be fireformed back to their original dimensions. If we use the wrong lube, we can really get into trouble with stuck cases.

A dented case shoulder. This case will need fireforming to push out the dent.

The application and usage of lubricants can be a trying time for those new to reloading. In plain terms - it takes a degree of practice and experimentation to get things right. Bugger!

Summary of Key Points:

- Lubricant critical with most brands and types of die.
- Use a wax based lubricant for full length sizing operations.
- Use dry lubricant for neck sizing operations only.
- Take care when applying lubricant, avoiding lubricant on the case shoulder.

Reloading tray

A reloading tray is used to sit cases in during our reloading operations and becomes most important when dispensing powder into cartridge cases.

Most reloading companies furnish a reloading tray. My personal preference is to drill holes in a block of 6x2 timber, as I prefer the heft of timber which is not easily shifted if accidentally bumped, minimizing any risk of powder spillage. If using timber to make a case block, make sure the timber is fully seasoned and dry - we don't want moisture creeping up through open primer pockets during warm conditions.

A simple and sturdy homemade case block.

Vernier calipers

A Vernier caliper is perhaps one of the most important reloading tools you will ever own. Not only can the caliper be used for measuring COAL, but it can also be used to measure bullet diameters and case neck thickness in lieu of a micrometer. This tool is also immensely useful for other chores in the home (diameter of your cat) or workshop (screw thread diameters or parts sizes) and being such a useful tool, it is worth putting aside funds for a decent quality unit. My favorite brand is Mitutoyo. I use a basic analog caliper which has neither a dial nor a digital read out. This has been quite sufficient for my needs over the years.

My Mitutoyo caliper along with my now very old micrometer which originally belonged to my grandfather. From Spitfires to rifles, this micrometer has been carefully looked after over the decades.

If you are new to reloading and need a Vernier caliper, I suggest the same basic analog system. A truly good dial or digital caliper can be extremely expensive, and most young folk tend to want the digital variety but end up with a cheap unit. Furthermore, by adopting a digital caliper from the outset, they will never learn how to read the Vernier scale of measurement. This system dates back to ancient Chinese history before being rediscovered by the French mathematician Pierre Vernier in around 1631.

I have had a young man call me "old school" for not using a digital caliper - that comment certainly caught me off guard. An analog Vernier caliper may seem old or daunting at first - but give yourself time to understand it and you will be just fine and feeling quite chuffed that you put the effort into learning the system. Later you may wish to move to an extremely precise dial or digital caliper. If your eyes cause you trouble, I thoroughly recommend a digital unit.

I would prefer to see readers adopt calipers with both metric and imperial readouts. This allows us to either develop or retain an understanding of our two common systems of measurement used worldwide. I am not a great fan of calipers with fractional scales, especially for beginners.

If you do not know how to use Vernier calipers, visit an engineer's supply store and ask for help. Do not try to wing it. Everybody has to start somewhere. Lastly, if you have any doubt as to brands, stick with Mitutoyo.

Make sure your Vernier caliper is kept clean and its working parts very lightly lubricated. Your Vernier is not a mini spanner or ninja throwing Vernier. It is a measuring tool only. Nevertheless, as a tid-bit of extra information: the only other job outside of measuring you may sneakily use the Vernier for,

is adjusting the parallax on scopes that have their parallax set incorrectly and have no parallax adjustment (e.g. no side parallax). A good example would be a .22 rifle which needs its parallax set at 50 yards but the scope is set to a typical 150 yards and is difficult to focus at very short ranges. After cracking and unscrewing the front bell cover on the scope (last half inch), you will find that the lens has a key way. The upper blades of a Vernier fit this keyway nicely and you will find that you can wind the lens in or out to fine tune parallax without stress to the caliper. That said - a Vernier can badly scratch a lens if you slip. Occasionally you may find that this task also needs to be performed on rifles with adjustable parallax, as the scope has simply been assembled incorrectly and focusing is extremely difficult regardless of focus and parallax provisions. It’s a bad way to use a Vernier, but there you go.

Summary of Key Points:

- A Vernier caliper is an important investment for handloading operations.
- If possible, utilize an analog Vernier to build or retain maths / measuring skills.
- Adopt digital calipers if eyesight is a concern.
- A mixed Imperial / Metric caliper can further improve math skills.
- Keep your Vernier clean and lubricated.
- Use the Vernier as it was designed - it is not a mini spanner.

Journal

It is extremely important that you obtain a good journal for your load data. When I started I used a heavy duty ring binding folder and clear files. After filling up two of these I moved to basic hardback exercise books while my client data is kept in computer files. A good solid journal is vital for recording data in the field and will last many years. There is nothing worse than notes falling into tatters. Even if you sell a rifle chambered for a particular cartridge you no longer use, there may come a time much later on when you buy another rifle of the same chambering and the old data may prove extremely useful for comparisons. Careful record keeping is a major contributing factor in successful handloading. Clear and tidy handwriting is also extremely important.

Summary of Key Points:

- Record keeping is extremely important.
- Choose a sturdy journal that will hopefully last a lifetime.

Kinetic bullet puller

A kinetic bullet puller (also called inertia bullet puller) is an extremely handy tool. This is basically a hammer-like tool which grips the case rim, and upon the operator striking the hammer against a very hard surface the bullet exits the case neck under inertia. There are also press mounted bullet pullers which are equally useful, but these can mar bullets slightly.

A bullet puller can be used for two common purposes. The first is the disassembly of ammunition after a mistake has been made. The second application is for the disassembly of loads after incremental load development. If for example you make up a batch of ammunition ranging in charge weights from 42 to 44.5 grains and then discover that the rifle is producing maximum pressures at 43 grains, it would be unwise to shoot off the hotter ammunition as a means to recover brass. A far safer method of brass recovery is to simply pull the loads. A bullet puller can really save a great deal of hassle.

A kinetic bullet puller.

One quick tip: if you adopt a kinetic bullet puller, place an ear plug at the bottom of the puller to catch projectiles without deforming the tips. But, if you use an earplug be very careful with any trapped powder around the ear plug. If left behind

after bullet pulling operations, the powder could become mixed with another powder later on.

Summary of Key Points:

- A kinetic bullet puller can be extremely useful when handloading.
- Place an earplug in the puller to minimize or prevent bullet tip deformation.

Brass selection

If we are to achieve desirable rifle accuracy, we need good brass.

Brass selection for the basic hunting rifle is relatively straight forwards. Brass cases can be purchased new or recycled from once fired factory ammunition. A main point that new handloaders need to understand is that older European military brass (military calibers) was often Berdan primed. Berdan primed cases feature two small flash holes rather than the more common single central flash hole and these cases cannot be de-primed with normal reloading dies. Put simply, it is best to steer clear of Berdan primed cases and adopt cases that utilize the standard Boxer primer system.

Modern military brass can also sometimes be problematic due to the cases being extremely thick, reaching full pressures at much lower charges than commercial sporting brass. Military brass can also sometimes prove less uniform than sporting

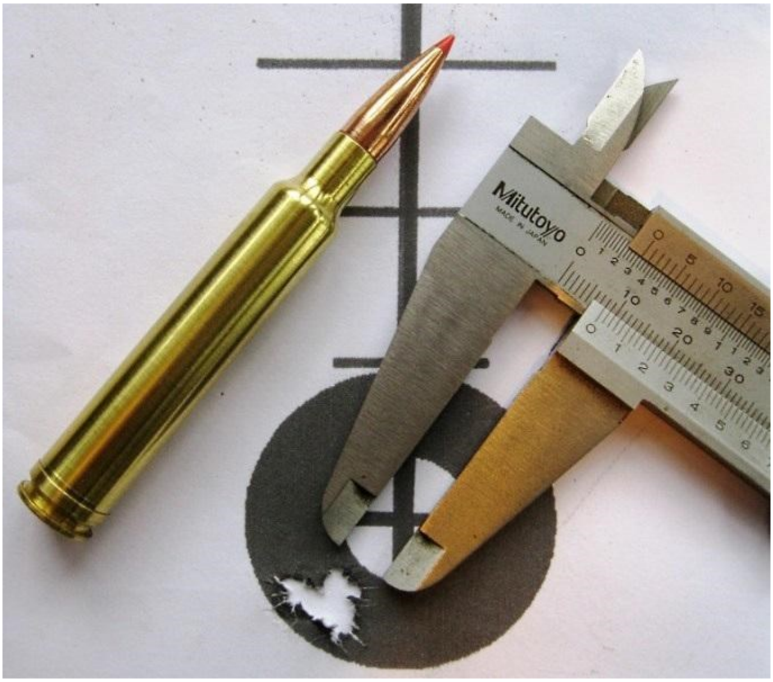
brass. Steel cases are also becoming common now. These can sometimes be reloaded but may prove hard on reloading equipment. If you are new to reloading and are shooting a military caliber, please approach the use of military cases with great care. If in doubt, simply use commercial brass from one of the many reputable component manufacturers.

With the commercial brands, one factor to be careful of is that European brass can be much thicker than US brass, resulting in reduced case capacity and potentially higher pressures when working up loads. Hirtenberger, RWS and Prvi (stamped NNY) generally have relatively heavy case walls, while Norma and Lapua are generally very similar to the US counterparts. Heavy, thick walled cases will sometimes allow us to reach the same velocities as thinner walled brass regardless of case capacity. The main concern here is simply how we approach load data, exercising due caution. Prvi is interesting in that although the brass is quite heavy, it can be very soft. This can sometimes give the impression that the rifle has reached maximum pressures very quickly due to sticky extraction after the brass has flowed into ejector slots or plunger holes. Nevertheless, there are times when Prvi is very useful to have on hand regardless of its idiosyncrasies, simply because of the European cartridge options within the Prvi range.

US brands of brass tend to be relatively uniform and Winchester, Remington, Federal and Hornady can be put to good use. That said, Federal brass can be very soft.

The most carefully controlled brass is that of Nosler which I believe is made by Norma along with both Lapua and Norma factory brass.

For my own part I prefer a brass case of good capacity and one that is tough. Sometimes I come across a rifle that displays greatest accuracy at high pressures and if using brass without a tough primer pocket, the pockets open up after a short period, rendering the brass useless. My favored brands of brass are Winchester or Lapua - both tough brands. That said, I also use Hornady which is quite tough along with Norma, Remington, Federal or Prvi which are all rather soft brands of brass. Decisions on which brass to use are sometimes dependent on the cartridge design versus brass availability. In the Weatherby chamberings, I use Norma brand brass due simply to its very high quality and uniformity along with the fact that Weatherby based their cartridge designs on Norma brass and case capacities. Furthermore, some of the Weatherby cartridge designs are not supported by other brass manufacturers, so there is no other choice but to use Weatherby / Norma brass.



A .300 Weatherby handload utilizing Norma brass.

When it comes to extreme accuracy there are basically two schools of thought. The first is to buy the best brass that money can buy. If the brass is of very good quality it will not normally need batching. The second method is to employ a basic brass like Winchester, bin the worst cases (normally one or two will have split necks in a pack of 50), then set about working up loads and seeing how she goes. Some benchrest shooters will buy a lot of around 150 cases, then sort the cases into batches based on weight. This can, for example, result in three batches of three averaged weights. The handloader will then set about developing three different loads or he may allocate optimal brass to target shooting and cull brass to moderate range hunting.

Personally, I go for the minimalistic approach. I buy brass, I shoot it. If I am struggling to achieve optimum accuracy, or more particularly a low ES, I may batch weigh cases. But during my many years working in the accuracy game, case weight variations have never been a major factor in rifle accuracy unless there was a major problem with the batch of brass. Nevertheless, ES can certainly be affected and groups can be tweaked a touch with careful brass selection.

When weighing brass it is quite common to come across weight variations of around 2.5 grains and sometimes as much as 4 grains. Many match shooters try to get down to 1 grain or less in order to lower ES. My advice to you is this: If you want to batch weigh cases - that is entirely up to you. If you don't want to batch weigh cases, that's fine too. But if you want to shoot long and find that your ES is very high after load development, case weighing is something you can play with during the later stages of load development as a means to fine tune loads.

Summary of Key Points:

- Try to utilize a brand of brass which offers both good case capacity, but is also tough.
- Batch weigh brass as an option or as a part of problem solving, not generally as an immediate necessity.

Powder selection

Let's face it, most of us want to drive our loads as fast as possible. The trick is keeping pressures to a minimum. This balancing act goes a step further as we introduce accuracy into the game. Now we have three goals: high velocity, low pressure, excellent accuracy. Sure, sometimes we may want a mild load to minimize recoil or meat damage, or perhaps the rifle simply won't shoot a fast load very well. But outside of these conditions, boys (and some girls) like to play. And to play we need an appropriate powder.

A common approach is to choose the slowest powder that will yield the highest potential velocity. If you refer to your powder manufacturers booklet or website, you will see that for a given cartridge and bullet, the powder manufacturer will suggest a range of powders suitable for that cartridge and bullet. Small cartridges such as the .223 utilize very fast burning powders while large cartridges require slow burning powders. For each cartridge the powder manufacturer's list begins with the fastest burning powders through to the slowest that are suitable for that particular cartridge. Sometimes however, the very slowest of powders may not yield the highest velocities. For example, a very slow burning powder can require a long barrel to achieve its full burn and energy release. If you have a short barreled rifle, a slightly faster burn rate than the slowest listed may be a better option. Another example is where the powder is simply so slow that you cannot fit enough into the case to achieve full potential velocities. So, we have to find a balance.

I prefer a powder which (based on its burn rate) achieves full pressures while filling roughly 90% (or near 100%) of the case. This ensures that the case is not under loaded which may result

in a poor ES or in worst case scenarios uneven burning and potentially dangerous pressures.

If you are really stuck and don’t know where to start it can be best to pick a powder from the middle of the list supplied by the powder manufacturer for a given cartridge and projectile. If shooting a magnum rifle cartridge it can pay to work with the slow powders. In this case we can take the middle burn rate suggested, then pick a powder halfway between this middle burn rate powder and the slowest suggested powder. Over time you will gain an understanding of which powders generally work in which cartridges or rifles, based on either your own findings or published findings which display general trends. The Load From A Disc program can also be highly useful for powder selection.

There are two general types of powder manufactured worldwide - single based and doubled based. Powder shape varies from manufacturer to manufacturer and may consist of stick, ball or flake shapes.

Single based nitro-cellulose stick powders are very common and the burn rates are to a great extent controlled by kernel size. The larger the powder kernel, the slower the burn.

Double based powders feature a secondary nitro-glycerine content to increase energy. Vihtavouri for example produce both types: the nitro-cellulose type is found in their N100 series while high energy versions are offered in the N500 series nitro-glycerine powders. Both are stick type powders. A basic example of the Vihtavouri options would be N160 which works well in the 6.5x55 with 140 grain bullets while N560 offers a touch more punch.

Ball (spherical) powders are typically double based. These are quite different to stick powders in that the powder kernels are generally very small and therefore require a deterrent coating to control burn rates. Because of this coating it can be best to utilize a hot magnum primer for consistent ignition. In my experience, ball powders can produce changes in velocities depending on temperatures. A load fired at midday through a warm barrel may be as much as 100fps faster than an early morning cold barrel load. Pressures are affected accordingly. If you are using ball powders, I suggest that you check the rifle at different times of the day, in different seasons and at different barrel temperatures to make sure the load is safe.

From left to right: ADI 2217 (H1000) stick powder, Hodgdon US869 ball powder and IMR Trail Boss flake powder.

In my experience ADI powders are some of the most temperature stable powders on the market and are excellent to work with. Many of these are sold under the Hodgdon banner

and a study of the ADI reloading manual (either booklet or download) will hint at which Hodgdon powders were made “down under” in the powder equivalent charts.

Trail Boss powder is a flake type, very fast burning but with a very low bulk density (low - as in you cannot fit much in a case). Initially designed to mimic black powder loadings for cowboy action shooting, this powder is very useful for making reduced rifle loads and ideal for fireforming brass. That said, these low velocity loads can cause bullet instability due to a lack of spin. This can result in tumbling bullets, if the bullets used are too long and the twist rate of the barrel is insufficient for stability. It is therefore imperative that a safe range area is utilized during fireforming in case of potentially wide bullet deviation. Light for caliber bullets help minimize stability problems.

Summary of Key Points:

- Correct powder is critical for both safety and optimum performance.
- Use a reloading manual (booklet or website) to select an appropriate powder. Load From A Disc also highly useful.
- If possible, choose a powder which yields a 90% fill rate or greater while minimizing pressures.

Projectile selection and twist rate

To handload you will need to find projectiles of the appropriate caliber for your rifle. If you are new to this game, even this can be a little confusing, as cartridges are often named based on a number pulled from the ether because it sounds good. The .270 Winchester for example shoots a .277” bullet - but somebody somewhere decided that “two seventy” sounded much better. Then there is the .303 British, named after the land diameter of the Enfield as opposed to the groove diameter. The groove diameters of the Enfield rifles run between .311” and .312” and these are the correct bullet diameters for the .303 British. If you have any doubt as to which is the right bullet diameter to use in your rifle, seek advice from a gun store that specializes in handloading supplies.

Rifling within a barrel is utilized to impart spin to a bullet in order to keep the bullet stable during flight. Without this spin the bullet would turn over in flight, the base of the bullet being heavier (center of gravity) than the nose / point section of the bullet. But in its attempt to do so the bullet would tumble. To remedy this we use rifling to impart bullet spin. The rate of spin varies depending on the cartridge / bullet design and can also vary between rifle barrel manufacturers.

The twist rate of a barrel is expressed as a ratio. For example, in a 1:10 twist barrel the bullet completes one full revolution of twist per ten inches of barrel.

It is important that you select a bullet that matches the twist rate of your rifle if optimum accuracy is to be expected. You can obtain information regarding the twist rate of your rifle barrel from the manufacturer, and several bullet manufacturers supply information to help with bullet selection. Much information can

also be obtained from my research as presented on the Terminal Ballistics Research website within the Knowledge Base.

For those of you who have a degree of handloading experience, you may find this section somewhat tedious. Nevertheless, there are a couple of points we can cover here. If you do not know the twist rate of your rifle (perhaps a custom rifle), it can pay to try a couple of different bullet weights during load development from the outset. This may seem like common sense but sometimes, we get stuck in our ways and forget such things.

Insufficient twist rate can be better than too much twist rate. I know, other authorities often state that extra twist rate can increase bullet stability, but in today's world of high powered magnums speed increases RPM. If we increase both speed and twist rate, we can get into a bunch of trouble and ruin stability when combined with other factors.

I had a phone call from a gentleman who had picked up a .22-243 Middlestead from a deceased estate. The twist rate is unknown, a tight patch on a rod spiralled down the bore failed to show consistency. My recommendation was to start out with two bullet weights, a 55 grain bullet but also a bullet weighing between 60 and 75 grains. The twist rate may well be theoretically suited to 55 grain bullets, but combined with hyper velocity and increased RPM the rifle may like a heavy bullet. Experimentation is the key. This is not something that can be solved by what such and such once said in a gun magazine article.

I have seen a fair few experienced handloaders get caught out with super fast twist rates. It's actually a bugbear of mine, as these have caused a great deal of problems for bullet

manufacturers. It has resulted in the toughening of several bullet designs, which in turn has rendered them less useful for hunting due to poor bullet expansion. Too many handloaders get caught out during custom rifle builds: adopting super fast twist rates with high speed magnums, resulting in finicky and sometimes completely useless rifles.

Another consideration that has to be taken in the selection of a suitable projectile is magazine length. Several of our modern long range projectiles simply don't work with certain magazine designs. If the bullet is too long, it may have to be seated so deep that the ogive of the bullet (that's the tapered bit that ends in the pointy bit) will be inside the case neck - a real no no, as the bullet will not be gripped securely. In extreme examples powder capacity may be severely reduced. I will not delve any further into various bullet designs or magazine lengths here, as this information can be sourced from our Knowledge Base and also found within the Long Range Cartridges book of this series which goes into further detail regarding long range projectiles.

Summary of Key Points:

- Choose a bullet of the correct diameter for your bore.
- Choose a bullet weight which matches your twist rate.
- Too much twist can be a sin - in practice as opposed to theory.
- Insufficient twist rate can sometimes be rectified by increasing velocity.

Storage of powders, projectiles, primers and brass

This is an often overlooked topic and perhaps boring for most, so I will try to keep this brief. Please try at all times to store your powder and primers in a low moisture environment, preferably in a darkened area. I store my primers in sealable plastic bags or containers with silica gel. Far too many people leave primers sitting exposed in a damp workshop, while just as many retailers leave primers sitting in similarly damp environments. It's a basic premise - keep your primers dry.

Brass also needs to be kept in a clean and dry environment if it is to be ready for use. Projectiles can be stored away from sunlight to preserve their qualities long term, or left in a sunny warm area to encourage age annealing as explained in the Practical Guide To Long Range Hunting Cartridges.

One last little story: A farm owner once made the mistake of asking his farm worker to take over the process of weighing powder charges while the farmer attended to another matter. While he was gone, the farm worker tipped over the tin of powder by mistake. The powder was exposed to an unknown chemical on either the workbench or workshop floor (we will never know). The worker collected the powder back up and carried on, saying nothing to the farmer. Later, when the farmer fired off a shot, pressures were all over the show. I tried to remove a projectile with a bullet puller, but the powder and now contaminated primer had become so volatile that the action of bullet pulling set off the charge with a black powder like fizz. Lucky I had ejected the bullet as the cartridge slowly ignited - no harm done. All I could do was guess that the farm worker had spilled and recollected the powder. I told the farmer to bury the waste ammo and powder nice and deep. The lesson

- besides making sure you assemble your own loads or utilize a suitably trained and aware operator - is to be extremely careful regarding potential contamination of powder and primers.

Sweat on the hands and fingers should be considered a contaminant when handling primers. Keep your hands clean and dry and handle the edges of primers only. If you can't manage this, use either latex gloves or adopt a tray or automated primer feed system.

Powder and primers must obviously be stored away from any sources of heat which may cause ignition. Basic safety instructions can be found on both powder and primer packaging.

Summary of Key Points:

- Store powder and primers in a safe darkened environment and keep dry.
- Primers often overlooked - again keep dry!
- Be vigilant of all possible contaminants, including sweaty hands.

The handloading process

The following is my basic process for setting up a new rifle when handloading for basic through to extreme accuracy.

1. **Make heading in Journal and record components.**
2. **Measure and record test projectile length in journal.**
3. **Take rifle, find and record maximum COAL.**
4. **Write down preliminary test loads.**
5. **Set up dies.**
6. **Size new brass or recycle used brass.**
7. **Trim and chamfer cases.**
8. **Clean and/or uniform primer pockets.**
9. **Flare case mouth (straight walled cartridges only).**
10. **Prime cases and fill with powder.**
11. **Seat bullet.**
12. **Fire off ammo (first batch will be fireforming).**
13. **Reset sizing die to correlate with rifle head space.**
14. **Work up accuracy test loads with fireformed cases in half grain increments.**
15. **Load more ammunition (if need be) to determine near maximum.**
16. **Observe sweet spots and work around sweet spots in .2 grain increments to fine tune accuracy.**
17. **Troubleshoot as necessary if accuracy remains poor.**

Let’s look at each of these steps in closer detail.

1. Journal work

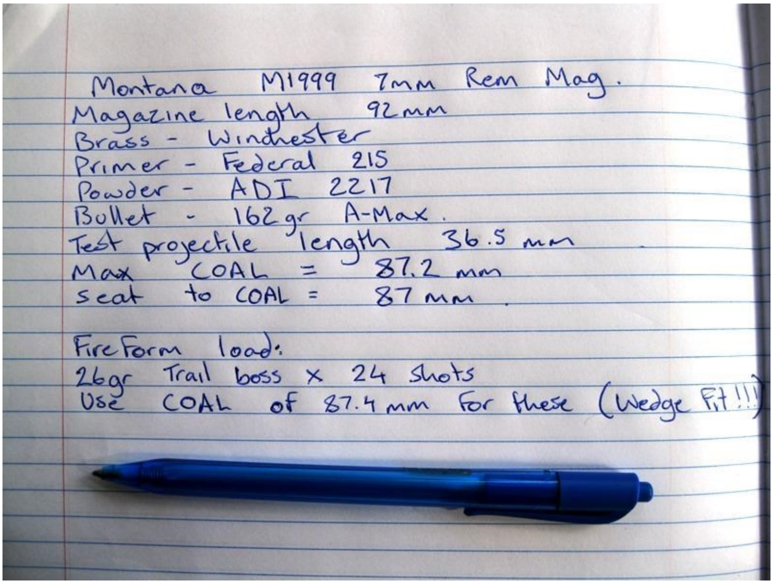
The information you need to write down includes:

- Rifle (e.g. My Remington M700 .308 Win).
- Magazine internal length (important to know versus COAL).

- Brand of brass (e.g. Winchester).
- Brand and type of Primer (e.g. Federal 210).
- Brand and type of powder (e.g. H4895).
- Length of test projectile.
- Maximum COAL (length of the cartridge if the bullet is touching the lands).
- Test COAL (will be different to the maximum COAL).
- Test loads.

Other notes of use may include:

- Serial number of rifle (if you wish to record this).
- Usable magazine length (Internal length minus 1mm / 40 thou to ensure smooth feeding.

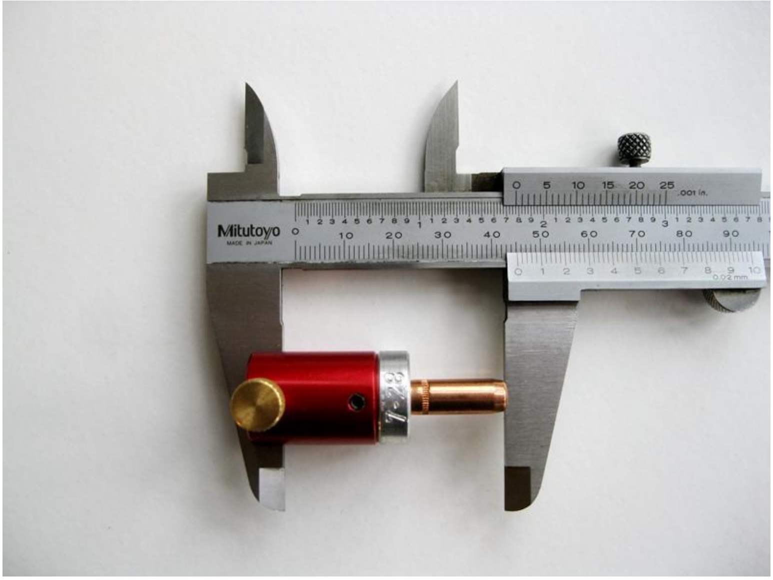


Good record keeping is extremely important.

2. Measure and record test projectile length

This is a generally overlooked subject. The thing to understand here is that projectile lengths vary within a box of projectiles. This is one of the most common mistakes I see, one that catches out new players and experienced shooters alike.

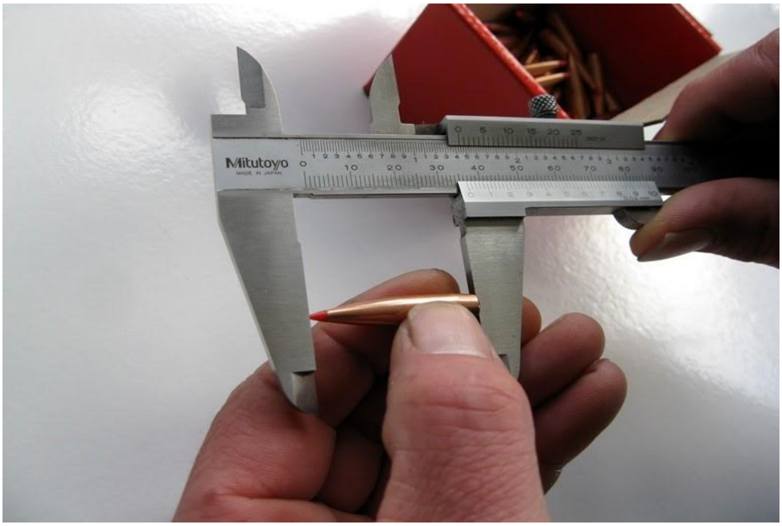
A bullet comparator can be used to record the length of a projectile from its base to the comparator reference point (see picture). Jot this down and mark the projectile with a vivid marker pen before placing it back in the box or on your bench.



This Hornady comparator can be attached to a Vernier caliper. The handloader can then record the combined length of the projectile to its ogive reference point plus the comparator as shown. Or he can measure the combined length of the projectile

and comparator, then measure and subtract the length of the comparator without the projectile. Either method is fine.

If you are not using a comparator, measure the length of several projectiles from the box using your vernier calipers which you are now in love with. Pick a bullet of a common length, record the length of this projectile, then mark the projectile with a vivid marker pen before putting it back into the box or onto your workbench.



Measuring the OAL of a projectile with my trusty Mitutoyo.

3. Determine maximum COAL

To begin with, if you are reloading for a tube magazine fed rifle such as the .30-30 Winchester or loading handgun cartridges there is no need to determine the maximum COAL. Flat point projectiles designed specifically for these types of cartridges

feature a cannelure for crimping. Simply seat your projectiles to this cannelure and crimp in place. This approach can also be useful for gas operated rifles, utilizing Hornady Interlock or SST bullets.

When handloading bolt action rifles for optimum accuracy it is useful to understand the subject of cartridge overall length, generally expressed as COAL. Another common acronym is simply OAL (overall length).

If the COAL is wrong and the cartridge is too long, pressures can rise to unsafe levels in some cases. Loss of accuracy is another major problem that can sometimes occur if the COAL is too short and concentricity poor. Determining COAL is about finding the optimum length of handloads for your individual rifle.

I remember many years ago guiding a client who had his COAL wrong, the loads were too long. The rifle had proven accurate with the projectiles wedged into the lands and the client had stuck to reloading manual powder charge recommendations which kept pressures safe. Just a few minutes before dark I spied a boar, a good specimen at around 300 yards on an opposite ridge. The client quickly got into position, chambered a round and waited for a clear shot as the pig moved through the Raupo - a type of tussock we have here (handy for thatching the huts on The last Samurai movie set). A minute passed before the boar reappeared a bit further on - the client would have to change position quickly. The client quickly opened his bolt to make the rifle safe (a sporterized military rifle with the safety blocked by optics), picked a new mound, got down and hello - the bolt would not close. The projectile had remained jammed in the rifling, neck tension of the case was insufficient for extraction, the case came away and powder spilled into the

chamber creating a fair jam. Fortunately I had my rifle just a few yards away. Lesson: understanding COAL is very important and to this end, the following text is roughly the same as that found in my second book (Long Range Cartridges) and also on our website.

No time for jams!

If you are very new to handloading, you may find the information ahead to be a little overwhelming. The safest way to approach this subject (if you do not yet wish to delve into it) is to either purchase projectiles with cannelures and seat bullets to the cannelure or follow manufacturers recommendations. Yet again, Lee come to the rescue by offering suggested maximum cartridge overall lengths amongst the instructions that come with their die sets. These maximum overall lengths tend to err well on the side of caution but are very useful for beginners.

Personally, I would suggest that you learn to determine the true maximum COAL (explained ahead) for your rifle as soon as you begin handloading. But again, some of you may find this subject initially overwhelming.

Summary of Key Points:

- Understanding COAL is important.
- Learn how to determine the maximum COAL for your cartridge.
- If you do not wish to delve into this subject as a beginner, utilize Hornady Interlock or SST projectiles and seat to the cannelure or utilize Lee dies and follow the COAL instructions supplied.

Method 1 - the Cleaning rod trick

I will admit I have been reliant on this method for many years. You need a good eye to get the best out of this.

For this method you will need:

- Your pre-measured projectile.
- A cleaning rod with a male thread.
- A clothes peg and pen or sharp pencil.
- Dowel of some sort.

The male fitting on the cleaning rod is very important. This needs to have a square center face.

Female cleaning rod tip (left) versus male.

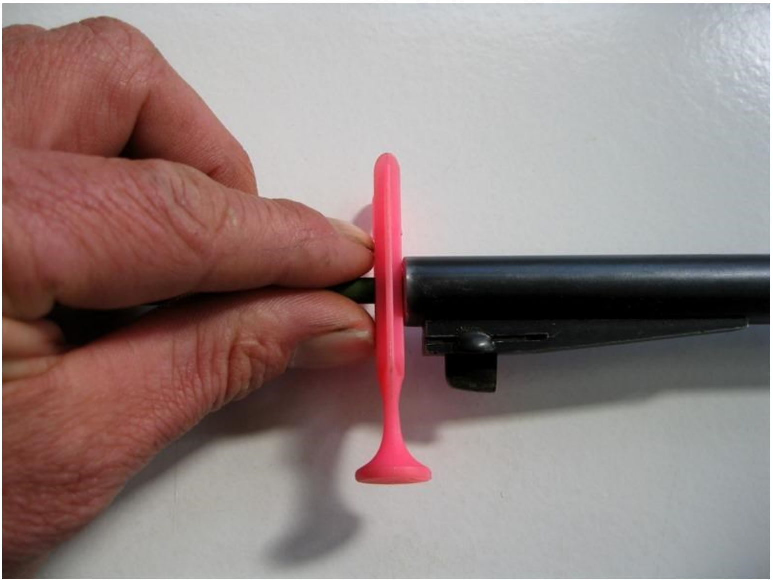
Method:

Make sure magazine and chamber are empty.

Cock the rifle on an empty chamber (do not pull the trigger as the firing pin will protrude and ruin the measurement).

Take a cleaning rod and carefully insert it down the muzzle to touch the bolt face.

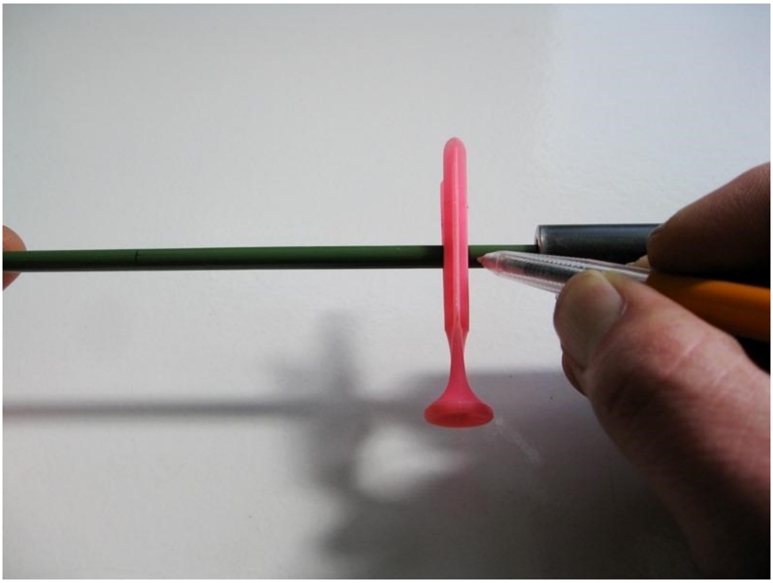
Take the plastic clothes peg and fit it to the cleaning rod near the handle, then slide the peg down the cleaning rod, butting it against the face of the muzzle.



Slide the rod down to the bolt face (firing pin must not be protruding!), then slide the peg down to the muzzle.

Remove the rod a short distance, being careful not to bump the peg.

Mark where the peg is sitting (mark the side of the peg closest to the barrel) using a fine tip pen at an estimated angle of 45 deg at the intersection of the peg and rod. Make sure your peg and line remain square during this operation.



Withdraw and mark the rod.

Leave the peg on the cleaning rod - slid back near the handle again.

Next, remove the bolt and carefully drop your pre-measured projectile into the chamber.

Drop a projectile into the chamber.

Use a dowel, another ram rod or something similar to place against the base of the bullet. Apply very light pressure to the base of the bullet. This will keep it touching the lands.

Use an opposing rod or dowel to push and hold the projectile in place.

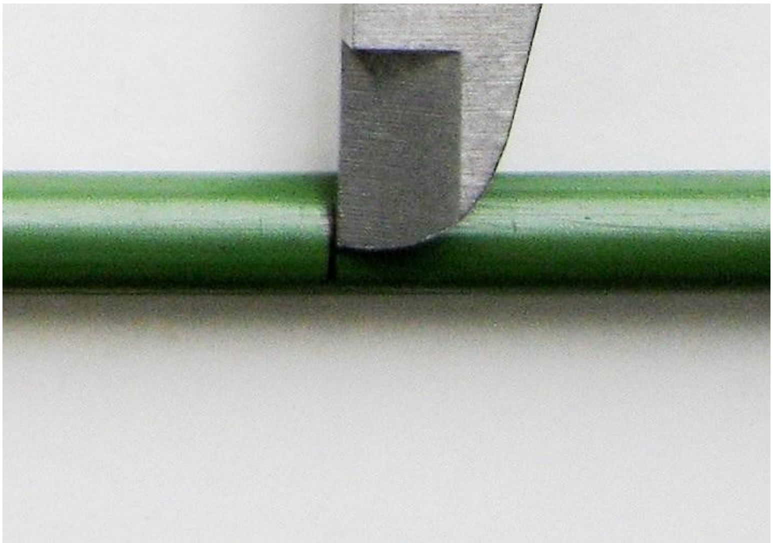
Re-insert the cleaning rod into the bore, push the rod down until it touches the projectile. If you push too hard you will feel this in the hand that is holding the dowel and you will need to push the dowel forwards again.

Now, slide the peg down the cleaning rod until it again touches the muzzle squarely.

Gently withdraw the cleaning rod a few inches, then mark the intersection of the peg and rod once again. Make sure you mark the side of the peg closest to the barrel, not the offside.

You will now have two pen lines. Place your Vernier against these to determine the COAL. To ensure your eyes do not play tricks on you, measure the distance to the center of the lines.

Then as a second step, measure to the front of the pen lines. The readings should be the same.



Measuring the pen lines. In this instance I am measuring to the front of the pen line.

You have now established your **MAXIMUM** COAL - don't forget to carefully record this in your journal.

Method 2 - the dummy round

To utilize this method, you will need a fired case or have a means of loosening an unfired case neck.

Method:

Take a fired case and size the neck in such a way that only 1mm / 40 thou of the case neck is sized.

Make sure the primer is not able to interfere with readings. If the primer has a protruding crater, the primer needs to be removed or the burr simply drilled away.

Insert your pre-measured projectile into the case neck so that it is just started.

Liberally coat the intersection of the ogive and bullet body with a lubricant to prevent the projectile from binding against the lands of the bore. Avoid placing lubricant on the bullet body behind this intersection, as the lands may still grip the bullet and pull it out of the case neck if the projectile is not held securely, resulting in a false reading.

Chamber the cartridge, then extract it very carefully. Measure the COAL. Repeat the process at least two more times. The process must be repeated in this manner because unfortunately there is always a possibility of the bullet becoming gripped by the lands of the bore, producing false readings. This is most evident in new bores which may have coarse machine marks in this area.

After repeat testing, take the shortest reading and write this number down as being your maximum COAL.

There is also a variation of this method which can be useful. This method is the same as just described but 5 minute (or slow cure) double syringe epoxy is applied to the inside of the case neck, making sure no epoxy spills onto the outer case neck. Once the dummy round is chambered and the projectile is pushed into the case, let the epoxy set. Once set, the dummy round can be extracted and the COAL recorded.

Method 3 - Overall length gauge and comparator.

Many authorities agree that measuring COAL from the base of the cartridge to the tip of the projectile is a less than optimal approach due to the variations in length from projectile to projectile. It is therefore suggested that the COAL be measured from the base of the cartridge to a reference point on the ogive (taper) of the projectile. This certainly has merit, especially when it comes to lead soft point bullets and many match bullets with rough edges at the bullet tip, all of which can lead to inaccurate readings. Nevertheless, I have come across variations in ogive measurements. To this end, we need to maintain a balanced perspective as to what we can achieve when measuring COAL off the ogive.

Reloading manufacturers now produce specialized tools for determining maximum COAL using the ogive of the projectile as a reference point. Bear in mind the reference point on the ogive can be different from manufacturer to manufacturer and also depends on tool tolerances - so all readings obtained should be regarded as pertaining to your rifle, only with the tool you used to take measurements.

A most basic and functional tool is the Hornady Lock N Load Overall Length Gauge which must be used with a Hornady Bullet Comparator and a dummy cartridge case, its primer pocket threaded to suit the Lock N Load gauge. Hornady provide clear instructions on how to use this tool. The downside of the Lock N Load tool is that you need to obtain the threaded dummy cartridges utilized by this system. This pretty much excludes wildcat operations. Nevertheless, for those wanting a simple

starting point, a Lock N Load Overall Length Gauge can be useful.

A Hornady Lock N Load OAL gauge. The dummy case and loosely fitted projectile are simply pushed into the chamber. The inner plastic rod can then be pushed forwards which in turn pushes the projectile up to the lands (rifling). The retaining screw at the rear of the tool can then be tightened, securing the measurement.

In this photo, the Hornady OAL gauge and comparator are being used to measure the maximum COAL (OAL).

Sinclair produce a Bullet Seating Depth Tool which does not utilize threaded dummy cases and instead utilizes fired cases from the rifle.

Both the Hornady and Sinclair tools have one major limitation. The COAL is referenced off the distance between the shoulder of the case and the ogive - not the actual bolt face or true head space. If the threaded dummy round is shorter than your chamber or if the fired case (Sinclair method) has sprung back and is not tightly fitted in the chamber, the readings will always be slightly incorrect. Such are the complexities of reloading, as we venture deeper into the rabbit hole.

Further methods

We can quite easily combine methods. For example, we can use method 1 followed by method 2, then check both measurements to see if they are the same. We can also use either method 1 or 2 in conjunction with a comparator, recording the maximum COAL to the tip of the projectile while also recording the maximum COAL measured to the ogive of the projectile with a comparator. These are all methods we can utilize to double check the precision of our maximum COAL measurements.

There is one other method I have come across for determining maximum COAL. This method involves cutting a dummy case (full length sized) through the neck with a Dremel and cut off disc, creating a collet style dummy round. A projectile is then placed / started in the case mouth and the dummy round chambered in the rifle in the same manner (and with the same concerns) as method 2. Having recently experimented with this myself, my advice is to use two cuts (slots) as opposed to four. With four cuts bullet grip is very weak.

The collet method. The projectiles are lubed at the ogive and ready for COAL testing.

Double checking

If you are attempting to seat close to the lands you may want to perform a final check to make sure that your bullet is not wedged into the lands, especially if the rifle is to be used for hunting. Let’s say the max COAL was 87mm or 3.425” touching the lands. And let’s say you want to seat bullets with .2mm or perhaps 10 thou jump. Take a vivid pen, mark the ogive / bullet body junction, let it dry. Dump the dummy round into the chamber and close the bolt. Extract the dummy round carefully; you'll need to guide it out with your fingers to stop the extractor forcing the bullet against the chamber wall and scratching up the bullet. Check for rifling land marks on the projectile. If there are land marks, your initial measurements may have been

wrong. If need be you can carry on with this final method for determining the max COAL, seating the bullet 5 thou deeper before each retest.

How to use your COAL information

Having collected your COAL information, there are three factors of importance that need to be taken into consideration. Many handloaders neglect these issues, **so it is important that you read and understand the following information to achieve optimum results.**

The factors to consider are:

- Available magazine length.
- Freebore - especially acceptable freebore.
- Case neck guidance and concentricity.

Let's have a close look at each issue.

Magazine length

Many modern rifles simply do not have a long enough magazine to utilize a near maximum COAL cartridge. In such situations it is impossible to seat close to the lands unless you are willing to single feed - something I try to avoid if at all possible.

In my first and second book I have tried where possible to include magazine lengths of various rifle brands versus the consequences of these magazine lengths. If possible you should try to adopt a rifle which has a magazine length that is complementary to the cartridge it houses. If you are a beginner you may find this subject frustrating, while also thinking: Surely the people who make the guns know what they are doing.

Unfortunately some rifles are just not built to optimum specifications due to cost factors.

As suggested previously, you will hopefully have recorded the magazine length of your rifle in your journal. If your maximum COAL is much longer than your internal magazine length, you will need to seat bullets to suit the magazine length - not the bore. You will also need to remove an extra 1mm or 40 thou from your internal magazine length and seat to this length - in order to ensure smooth feeding from the magazine and avoid jams.

Summary of Key Points:

- The magazine length of your rifle will affect how long you can load your ammunition - if you intend to feed ammunition from the magazine.
- Take the magazine internal length, then remove 1mm / 40 thou from this figure to determine the allowable length for smooth feeding.

Freebore

Sometimes it seems that the magazine of a rifle is too short, when the actual issue is freebore. All rifles are designed in such a way that the beginning of the bore is made slightly oversized and without rifling for a short distance. But in some cases this

distance can be quite long, the freebore acting as a gas expansion chamber to allow extra velocity generation while keeping pressures down. In the most crude terms, it is almost like having a bit of extra case capacity.

Many people are familiar with such cartridges as the Weatherby designs which have a large measure of freebore. With these cartridges we cannot normally seat close to the lands. However, a great number of handloaders do not understand that some of our most common cartridges are designed with freebore. The .308 Winchester is a classic example. The freebore of this cartridge was designed to offer maximum potential power from the .308 Winchester case while also preventing jams in dirty military rifles. This allowed engineers to produce a very potent cartridge for military applications - all the while achieving excellent performance in short 20” barrels.

As new cartridge designs came along, based on the .308 Winchester case, the same approach was used - regardless of the fact that the cartridges were for civilian use only. Therefore both the 7mm-08 and .260 Remington were given the freebore treatment to aid velocity generation. All three cartridges have great accuracy potential when loaded for optimum guidance and concentricity, a subject which we will discuss ahead.

There are several cartridge designs which utilize freebore for power generation. The most common are the Weatherby cartridges, the Remington Ultra Magnum cartridges, the .260 Remington, 7mm-08 Remington and .308 Winchester. Some cartridge designs do well with a measure of freebore, others not so well, the RUM’s sometimes producing finicky performance.

Most cartridge designs have a degree of freebore built into factory ammunition. As an extreme example, factory .300

Winchester Magnum ammunition is very short. But it is possible (in long magazine rifles), to handload in such a way that projectiles are seated close to the lands without the projectile sitting too far out of the case neck.

For those who wish to understand a bit more about freebore , the following information may be useful.

From a reamer manufacturer’s perspective, the lead or freebore starts at the case mouth and is measured forwards to the throat which is the beginning of the tapered section of the bore.

From a shooter’s perspective, the throat (or freebore) refers to bullet jump, measured from the ogive of the projectile forwards to the start of the rifling.

In this sense, the word throat has two completely different meanings.

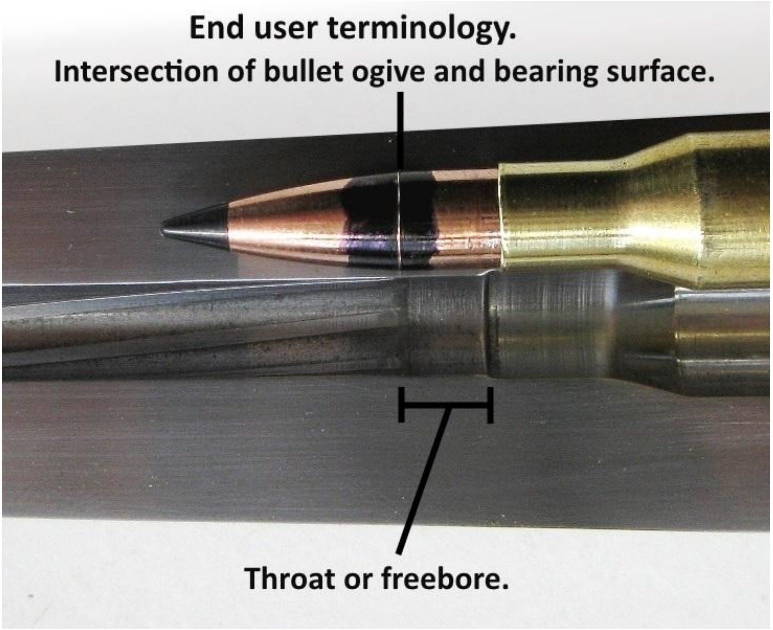
Reamer manufacturers use the terms freebore and lead (or leade) interchangeably. In other words, freebore and lead both refer to the area from the case mouth to the beginning of the rifling taper.

Reamer manufacturers use the term throat to describe the ogive shaped part of the reamer. This describes the length of the taper before it comes into contact with the projectile. The throat of a chamber has two important measurements (to the reamer maker), length and angle.

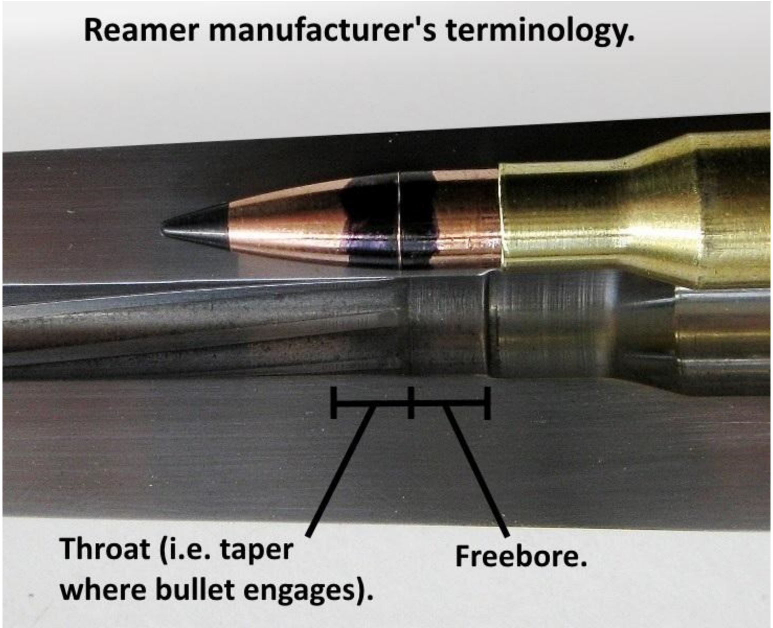
The usage of these terms can be confusing for industry outsiders. Fortunately reamer makers are innately aware of end user perceptions, assumptions and terminology. If you as a

consumer say that you want a long throated cartridge, they translate this into meaning a long freebore cartridge and will work towards this goal accordingly.

A throating reamer cuts both lead (freebore length) and throat angle.



End user's perspective.



Reamer manufacturer's perspective. Note the difference in the usage of the term throat.

Summary of Key Points:

- Try to understand what freebore is and how it applies to your cartridge / chambering.
- Freebore may be short or long, depending on the cartridge design.
- Long freebore is generally used for safety (especially military applications) along with power generation.

- Short freebore can be utilized to enhance accuracy within a cartridge design.

Case neck guidance and concentricity

If the magazine of your rifle is too short or where a degree of freebore is present, it is important to load for optimum guidance and concentricity (bullet squarely aligned to the bore with the case neck fully guiding the bullet) without worrying about bullet jump.

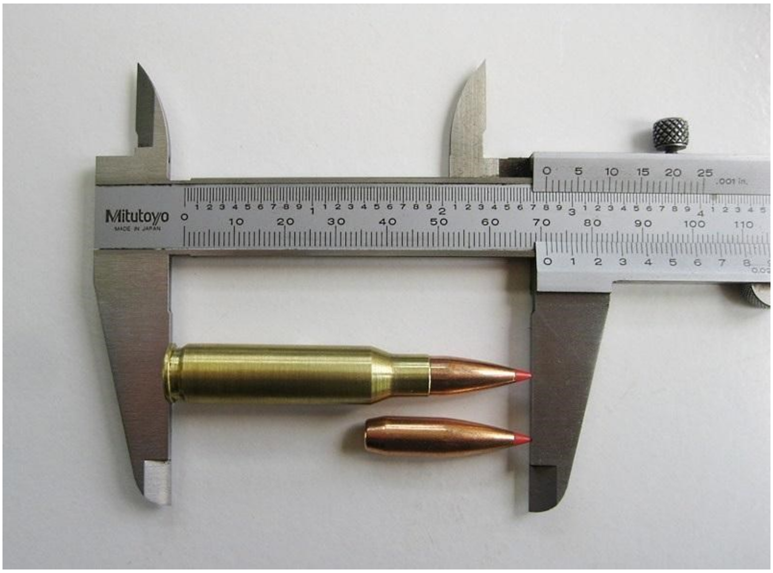
At this point, it may be best to provide a layman's example. Joe buys a .308 Winchester rifle. He has read an article about rifle accuracy where the author states that best accuracy is achieved when the bullets are just about touching the lands. Joe then sets out to make an accurate load and gets his bullets close to the lands. He then finds that his magazine is too short. He may then decide to modify the magazine of his rifle or he may decide to single feed. The trouble is, to get his bullets close to the lands Joe's projectiles are seated only a short distance into the case neck. There is no guarantee that his bullets have been seated deeply enough to square them up - unless Joe has a concentricity gauge to perform checks. With shallow seating the projectile may also easily be bumped out of alignment in the field, either during handling or feeding.

Not only does Joe risk poor concentricity, but he has also removed the ability of the case to act as a guide during ignition. The result: Joe's rifle gives poor accuracy and a poor ES - all

because Joe did his best to follow the advice from a well intentioned shooter.

This situation would be even worse if Joe was shooting a RUM cartridge design (e.g. 7mm RUM), as the freebore is so long that the bullet must leave the case neck, then perform a space walk before hitting the lands. If Joe does not have his bullet aligned prior to ignition and optimally guided during ignition, there is no way that bullet will hit the lands squarely after its space walk. And even if accuracy is sound at 100 yards, Joe's bullet may struggle at long range due to induced yaw.

If freebore is long, my suggestion is that projectiles be seated in such a way that the base or boat tail / body junction of the projectile is either flush or slightly below the neck / shoulder junction of the cartridge case.



A .308 Winchester case loaded with the 168 grain Hornady A-MAX for optimum guidance and concentricity. This COAL is also optimal for smooth feeding from short action rifle magazines.

During ignition the case neck will act as a guide. That said, the case neck itself expands during ignition, so this guidance is only temporary.

A term I commonly use for this style of bullet seating is seating for optimum concentricity. But a more accurate term would be seating for optimum guidance and concentricity.

An example of this term in use would be: The .300 Winchester Magnum can be loaded with 180 grain bullets seated close to the lands, but if loading 150 grain bullets we must seat for optimum concentricity (again, bullets flush with the bottom of the case neck).

As a final note, if you are loading for lever action or pistol cartridges, bullets should be seated to the cannelure provided on the projectile and crimped in place. There is no need to measure COAL when shooting such cartridges, unless you wish to simply investigate the cartridge design.

Summary of Key Points:

- Where freebore is long, utilize deeper seating within the case neck to obtain optimum guidance and concentricity.
- Try to avoid seating projectiles out in the case neck.

Rules of thumb for testing

So far you will have obtained your maximum COAL, checked this against your magazine length and also checked to see that projectiles will achieve optimum concentricity (not sitting too far out of the case neck).

If you are new to reloading and have read through the entire COAL section and are now utterly confused, purchase projectiles with cannelures swaged through their mid section and seat bullets to the cannelure or use manufacturer recommendations. This will take the pressure off, allowing you to investigate the subject of COAL in your own time.

If you are handloading for a tube loading rifle or handgun, you will definitely need to seat projectiles to the cannelure.

If your rifle has a short magazine or long freebore, you will need to seat for optimum concentricity.

If your rifle magazine and cartridge design allows you to seat close to the lands, you can then proceed to experiment with close seating depths.

The following are typical sweet spots for bullet jump I have noticed over the years when seating close to the lands (where concentricity and mag length is not a problem).

Match style open point bullets: Between .5mm and 1mm (20-40 thou). If bullet jump is too close, differences in ogive length from bullet to bullet can affect ES and accuracy. The Berger VLD often works well at 1mm (40 thou) jump.

Hornady SST and other plastic tipped bullet designs: Start at .2mm (8-10 thou), and if accuracy is poor trial .5mm (20 thou), then 1mm (40 thou) etc.

Soft point bullets: Start at .5mm (20 thou) and trial from there, experimenting with shorter COAL's as necessary. The longer jump also helps with regard to human error that may have occurred during the initial maximum COAL measuring process.

When writing in your journal be sure to write not only the maximum COAL but also the test COAL. Too often handloaders achieve a good accurate load, only to find later that they have not recorded the test COAL and have no memory as to what the bullet jump was having changed seating die settings for other experiments.

Summary of Key Points:

- If you are handloading for a tube loading rifle or handgun, utilize flat point bullets and seat projectiles to the cannelure.
- If your rifle has a short magazine or long freebore, seat for optimum guidance and concentricity.
- If your rifle magazine and cartridge design allows you to seat close to the lands, you can experiment with close seating depths.
- If you have no idea what to do, purchase Hornady Interlock bullets and seat to the cannelure.

Why seat close to the lands?

In our last example Joe read an article where the author stated that for best accuracy he should be seating close to the lands. Many of you will have heard this statement. Target shooters often go to the extreme and wedge the projectiles right into the lands - but why? The statement “because it is more accurate this way” is not really an explanation.

Current research suggests that by pushing the projectile into the lands pressures can be made more consistent from shot to shot. Lee have since produced their unique crimp die, offering hunters the best of both worlds, the crimped case producing even pressures but without the risk of jammed projectiles as occurs in target shooting from time to time.

I am a hunter first and foremost, so I cannot wedge bullets into the lands - as discussed regarding the wild boar incident. I can seat close to the lands, but if the ogive length (bullet taper) varies from bullet to bullet I do find that pressures will be uneven, with some projectiles touching the lands and others not - depending upon the spring back of the bullet during the seating process. In these situations I find it best to work with a bit more jump and utilize good neck tension as a means to even out pressures. Lee state that their concern with very tight necks (during the sizing process) is the potential for lost concentricity during bullet seating if the bullet is under a great deal of force during seating. Again, they recommend their crimp die as a solution to this, and if you have followed me so far you will see that Lee have a valid point.

I am not a great fan of rifles with short magazine boxes, necessitating long bullet jumps. A good example can be found in the Tikka T3 rifle chambered in .300 Win Mag. This rifle has a very short magazine box. If on the one hand we seat for optimum concentricity, there really is nothing to fuss over - the projectile will be guided squarely into the lands. If on the other hand the magazine was longer we could use a very slow burning powder and also utilize very sleek long range bullets weighing over 200 grains (for those interested in long range shooting). We could do this without any risk of the bullet’s ogive being in the case neck, which in turn would result in poor bullet grip and poor concentricity. Such a situation is simply unacceptable.

My Vernier is set to the magazine length of a Tikka T3 minus 1mm / 40 thou for smooth feeding. Within the caliper sits a factory Norma 300 Winchester magnum load which works well with this magazine length. But below this sits the wonderful 208 grain A-MAX, an excellent long range hunting or target bullet. If you look closely, you will see that if I tried to seat the A-MAX to suit this magazine, the ogive would be inside the case neck. Essentially a no-go situation.

The 7mm RUM would be one of the worst offenders regarding bullet jump. We simply cannot seat close to the lands when handloading for this cartridge - regardless of magazine length. The best we can hope for is highly concentric ammunition.

Another aspect to consider is chamber diameter at the area of the case neck. If the chamber reamer cut a very wide chamber (or the case neck is very thin), the case neck may open up to such a large diameter that it offers poor guidance. The projectile

may arrive at the lands slightly off center if it has to travel a long way. In this instance, having the bullet close and concentric to the bore can help minimize potential bullet yaw during ignition.

Close seating can also simply be used as a start point for harmonic experimentation. We can test the bullet up close to the lands, then step back if need be, monitoring the effects on accuracy. But we need to maintain a balanced perspective. There is no point seating a .308 Win projectile out close to the lands if the projectile is going to be hanging out of the case neck. In this instance ES may be poor (poor bullet grip), a donut may grow behind the bullet base in the case neck (ring / lump of brass) and the projectile may not be concentric to the bore with such shallow seating. Even if it is concentric, it may easily be bumped off center during handling and feeding.

Summary of Key Points:

- Close seating depths can be utilized as a means to obtain consistent pressures.
- Close seating can also be used to minimize bullet yaw during ignition.
- It can be used as a start point for harmonic experimentation.
- Close seating cannot and should not always be utilized. Horses for courses.

4. Write down preliminary test loads

At this stage I will only give a brief description of this subject, as I intend to delve much deeper into the topic of incremental load work further into this book. For now all I want to establish is that you keep good records.

You can obtain load data for your rifle from powder manufacturers, booklets and websites. Those of you who are very keen may wish to take advantage of a product called Load from a disc. This software requires a number of inputs which the novice may find intimidating, but it can be very useful when working with cartridges for which other data is sparse. Reloading booklets and manuals tend to be very cautious, while Load from a disc utilizes custom inputs to make more accurate calculations of the individual rifle's potential. In this manner handloaders, especially those with little confidence in using what appear to be hot loads, can extract the full potential power from their rifles. So, while Load from a disc may seem intimidating to new players, the program can be very useful.

Once you have a set of load data to work with write down your notes to include fouling shots and then write down potential three shot groups. If we take the .308 Winchester loaded with a 165-168 grain bullet as an example, the ADI and Hodgdon reloading booklets show a start load of 41 grains 2206H or H4895 powder and 43.5 grains as a maximum. Your journal should look something like this:

41gr x 2 foulers
41gr x 3
41.5 x 3
42 x 3
42.5 x 3
43

43.5

You will need to learn how to read pressure signs if approaching maximum loads. So again, all I wish to establish here is a set pattern to your journal work. If you have a chronograph and are recording velocities, you can then fill in the blanks during shooting, so that your journal reads as an example:

41gr x 3= 2560, 2566, 2574.

One important aspect to consider is that if your first loads are going to be fireforming loads (new or recycled brass that has never been fired in your rifle and is not shaped to your chamber), your first batch of ammunition may not produce the same results as consecutive loads. One option you may wish to consider is a purely fireforming phase, using ADI (IMR) Trail Boss powder and a cheap bullet. Trail Boss is a very low energy powder and extremely safe to use in rifles. By loading the case to between 90 and 100% capacity (remember to record your selected loads) Trail Boss will yield very mild velocities to the tune of 1400-1800fps depending on the cartridge.

Trail Boss can also be used to make subsonic loads (below 1100fps), but in this instance our focus is more on fireforming brass along with an emphasis on low throat wear (gas cutting). You can also use this phase to run in the barrel of your rifle if it has a new bore.

More fun than you can shake a stick at.

Your rifle will probably shoot about 6” low or more (at 100 yards) with Trail Boss loads. You can also use these loads to train youths - as an introduction to center fire cartridges.

If you decide not to use Trail Boss powder when fireforming brass, initial load work should be considered preliminary. In some cases I do find that if the brass is fresh and soft and the chamber is tight, loads will conform to the chamber in such a way that the results are similar to our final loads. Regardless, we should never assume that our first loads will be the same as our final loads. The same goes for exploring maximum power loads. When using new brass, the brass can absorb some pressure. But after fireforming, the cases may reach peak pressures with slightly less powder. So, in all cases we really have to treat the first round of load development as a preliminary phase.

Summary of Key Points:

- Preliminary testing is a fireforming phase.
- Seek reloading manual data for test loads.
- Keep good records.
- Work up in half grain increments.
- Trail Boss powder can be used to form cases.
- If testing full power loads, these will need reconfirming after the fireforming phase.

5. Set up dies

Finally, we can turn our attention to our reloading dies. To begin this process, we first need to understand head space and how this affects our reloading practices.

What is head space?

Head space is the distance from the bolt face of a rifle to a stopping point for the case within the chamber of the rifle. Without this point of reference there would be nothing to secure the cartridge case within the chamber and nothing to prevent the case entering the bore.

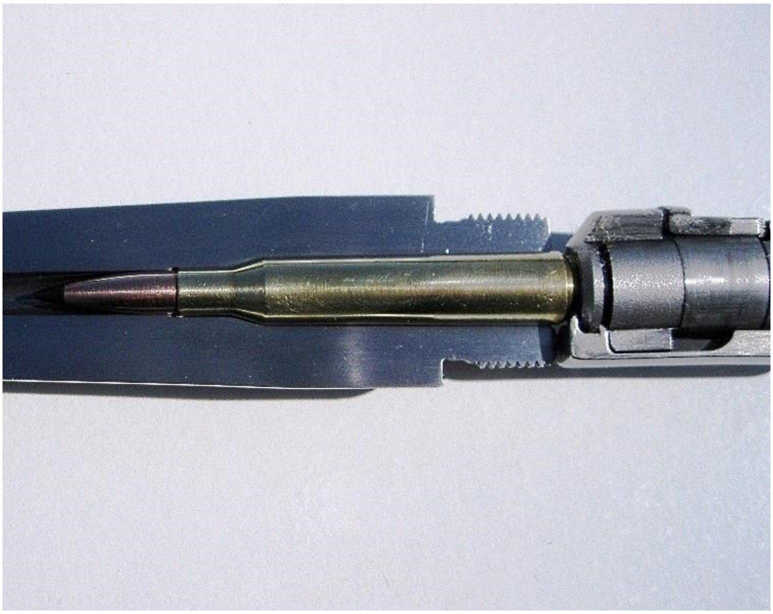
Rimmed cartridge head space is measured and achieved between the bolt face and the front of the case rim. Belted magnums are head spaced from the bolt face to the front of the case belt. Bottlenecked rimless cartridges are head spaced from the bolt face to the case shoulder.

When handloading it is better to fireform any case (rim or belted), so that all future sizing is based on head spacing to the shoulder in conjunction with the individual chamber dimensions, not the rim or belt. This achieves two major goals: The first is a potential increase in accuracy by reducing any play or misalignment forwards of the rim or belt (bullet aligned to the bore). The second is a decrease in case wear, preventing case head separation (cases splitting near the base). The practice of manipulating the head space of our handloads to suit the individual head space of our rifles cannot however be utilized with straight walled cases (e.g. .357 Mag, .44 Mag, .45/70), as these have no shoulder to head space against.

All rifles differ in head space but modern rifles are ideally within the parameter ranges set by the Small Arms And Ammunition Institute (SAAMI). SAAMI sets both the chamber dimensions for commercial rifles along with cartridge dimensions, including factory cartridge overall lengths which are often much shorter than handloads as a matter of wise caution.

Regardless of SAAMI efforts, long headspace rifles can occur; whether we are dealing with new or older rifles. If you wish to obtain optimum performance from your handloads, you will need to size your cases in such a way that you do not create excessive head space in your individual rifle. In essence, we need to avoid making our cases too small during case sizing operations.

A neck sizing die helps optimize correct head spacing (cases with shoulders) by allowing the shoulder of the case to come forwards and sit close to or against the shoulder of the rifle chamber.



A rifle barrel has two major sections, the bore and the chamber. The reamed chamber is not a part of the rifle action. In this photo we can see how the bolt of the rifle meets the barrel. Headspace for this .280 rem cartridge is measured from the bolt face to the case shoulder area of the chamber.

A full length sizing die can be set up in such a way that the case is reduced in dimensions, but only just enough to allow smooth feeding without excessive head space.

Excessive head space can be brought about via several factors. It may or may not indicate dangerous conditions. For example, the chamber of your rifle has generous (loose) dimensions and at the same time you have a minimum dimension FL sizing die. You screw this die down to the shell holder (like the traditional die instructions say) and inadvertently create a situation that could be described as excessive head space. On the other hand,

the rifle may be an older military rifle such as the Lee Enfield, assembled with chamber tolerances left particularly loose to ensure smooth feeding regardless of mud, dust or general grime within the chamber. Both of these examples could lead to a case head separation with undersized handloaded ammunition.

A more troubling situation occurs when the older military rifle is displaying excessive head space because the bolt locking lugs have stretched. This may also occur with modern sporting rifles if the rifle has been fired at near destructive pressures. If you find that your cases are stretching by an immense degree (case splitting on the first shot is a common indicator) take the rifle to a gunsmith.

Summary of Key Points:

- Head space is the distance from the bolt face of a rifle to a stopping point within the chamber.
- Long head space (whether due to the rifle or due to handloads) can lead to major problems.
- Avoid making ammunition undersized to prevent problems.
- Head space bottleneck shaped cartridge handloads at the shoulder, regardless of whether the case was designed to head space to the rim, belt or shoulder.

Neck sizing new brass

In this example we will be using new unfired brass. We will also begin with a neck sizing die. If you are starting with once fired brass (e.g. after firing off factory ammo in your rifle) or you are utilizing a full length sizing die, you can skip ahead to the next section.

Some of you may wonder why I do not simply place a bullet in new brass. The trouble with new brass is that the case necks may be dented. New cases may also need chamfering. To this end, it is better to prepare and size brass properly rather than simply priming and charging new brass.

The first step in this process is to load a batch of ammunition that will be used for fireforming our brass. As previously suggested, we cannot really do any meaningful load development at this stage as both accuracy and velocity may well be different to that of consecutive loads. Nevertheless, we can gain a glimpse of potential accuracy and velocities.

It is important to note that we may have to set up our neck sizing dies twice, the first time to suit the new brass, the second and final time will be to set the die to suit fireformed brass. Your chamber may be much larger than the dimensions of a new unfired cartridge case. It is therefore important to avoid making the brass undersized during future handloading operations as this may affect accuracy and brass life. If the case is a sloppy fit in the chamber, the bullet will be poorly aligned to the bore. If the case is overworked it may split at the case head (just forwards of the case rim), while the neck area of the case will need frequent annealing to prevent case splitting and

generally poor performance. To this end, setting up most dies (excluding neck collet / neck bushing dies) is a two step process.

To set up the Lee neck sizing collet die, insert the correct shell holder into the press ram , then lower the press handle, raising the ram to its top most position. Next, take the Lee neck sizing die and back off the die locking ring. Place the die in the press and turn down until the die touches the shell holder. Next, lower the ram and turn the die down one full turn. Following this, raise the ram so as to friction lock the die in place, then set the die locking ring in place.

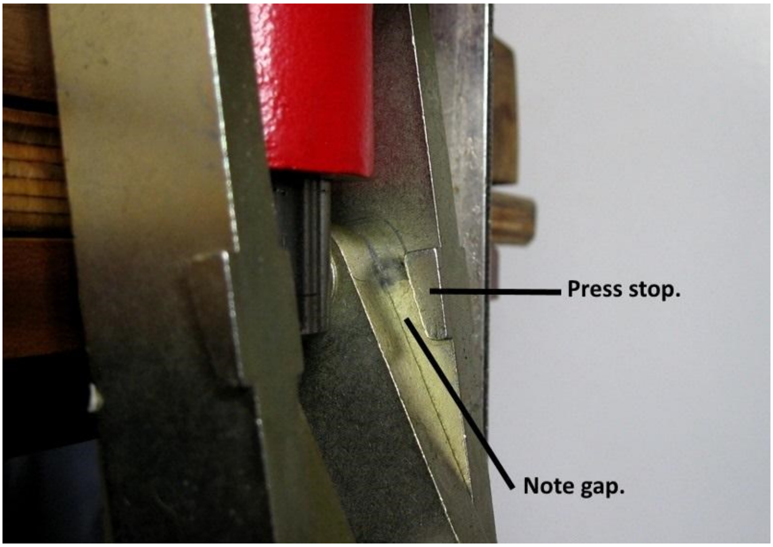
One important aspect to be understood is that Lee neck and seating dies require contact between the shell holder and dies - the shell holder has to mate solidly to the bottom of the die. Now - some types of press have a toggle over feature due to the nature of the ram linkage, you can feel the ram cam over. If using this type of press, the Lee neck sizing die needs to be wound in two turns past its initial contact with the shell holder to remove this cam over aspect. For those used to traditional toggle over presses this may seem a bit odd at first, but these dies are very much reliant on full contact.

Next, take a case and size it. There is no need for lubricant as the collet will push into the case neck, then release it. Lee state that a downward force of 25lb is necessary when working the press handle to gain optimum neck tension - not the easiest to estimate by feel. In my experience it is best to err on the side of excess rather than being too soft with these dies. Arm muscles need to be brought to <u>full</u> tension but without strain. If you have hanging scales for weighing game, place these over a door knob and push the scale hook down to obtain the correct feel

for muscle tension. Bathroom scales can also be used, placed on a table and pushed down with the palm of the hand.

Neck tension does vary depending on how much force is applied to the Lee die, requiring a high degree of muscle memory which in turn takes practice. My advice is to size - hold for three to five seconds, then release.

Lee collet die. The shell holder is touching the collet and pushing it up into a bushing which will swage the case neck to size. If the collet feels like it is not returning down after sizing, you may need to apply grease to the outer collet where it contacts the bushing.



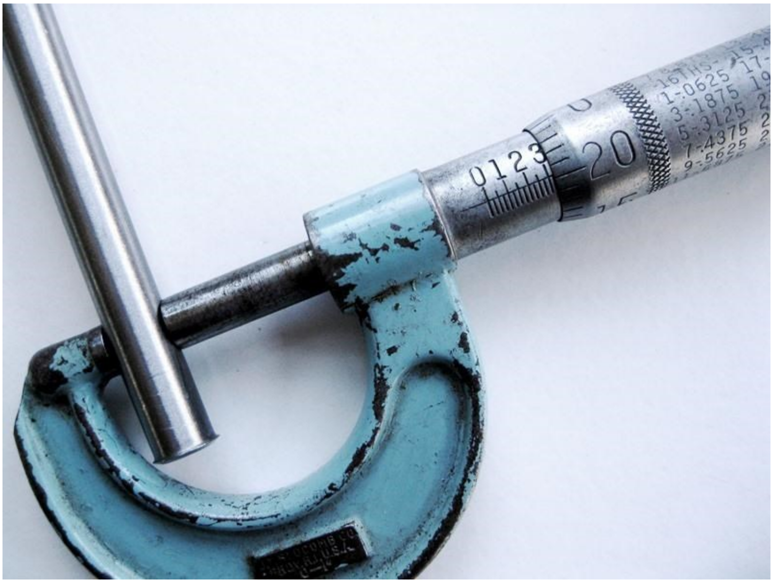
When using a Lee press with the Lee neck die, a gap is maintained in the ram linkage.

Having sized a case, take a projectile and try to seat it by hand. If you can start the bullet by hand, neck tension is too light - you need more welly.

Please note, you will also know if neck tension is insufficient when you seat a bullet with the Lee dead length seater. If neck tension is poor, you will not be able to feel any resistance during bullet seating. You need to be able to feel a slight level of resistance during bullet seating. If you do discover that you cannot physically obtain enough tension, the mandrel (decapper assembly) will need sanding.

To sand the mandrel first record its diameter. Measure the diameter close to the top of the mandrel where neck sizing occurs. Jot this down. Chuck the mandrel in a drill. Now take some new 240 grit sand paper. Fold the paper in half - it needs

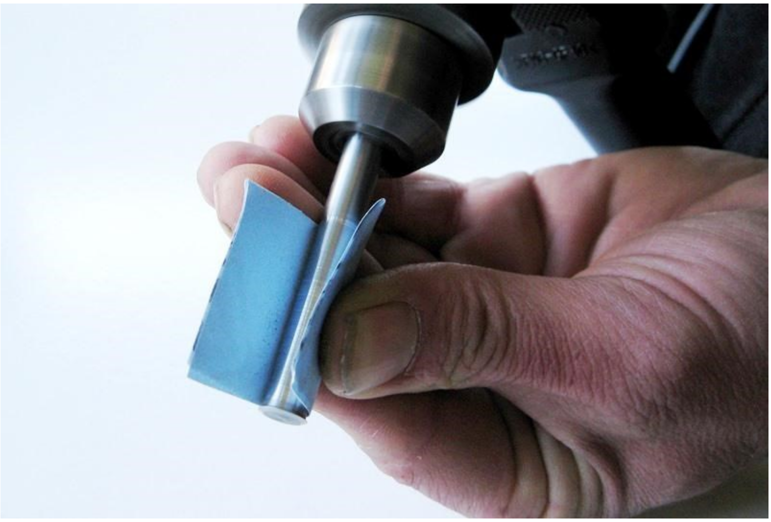
to be firm and not create high and low spots depending upon where your fingers are placed. Following this, sand the area of the mandrel responsible for sizing (top area of the mandrel) and count to ten. After your count, drag the sandpaper down the mandrel to bring the rest of the mandrel to the same / similar diameter (tolerances are not so critical down low - only at the area of the case neck). After this, measure the diameter of the mandrel again (top area). Lee state that tight neck tension can be gained with a 1 thou decrease in diameter however there is a bit more to this. A good example is a recent 8x57JS rifle I loaded for. The chamber for this rifle was cut with a very wide diameter neck to prevent jams under battle conditions. As much as the Lee neck sizing die tried to size the case to an optimum diameter, the case sprang back to a point roughly halfway between the die settings and the chamber dimensions. The case necks were simply too loose. I then sanded the mandrel down 2 thou (.002”) which produced optimum neck tension.



Use a Vernier caliper or micrometer to measure the diameter of the upper mandrel. Can you read a micrometer? This one is reading .3202”. The smallest lines on the bottom row are 25 thou (.025”) increments. Above the line, you can see the numbers 1,2,3. These are 100 thou (.100”) increments. This micrometer is showing the number 3 (.300”). The tool handle is calibrated in 1 thou (.001") increments. The tool handle shows the number 20 (20 thou / .020”) and a bit. It is closer to the number 20 than to the 21 hash mark. So I have called it at .3202”. In essence, .320” plus a bit!

The one difficulty with sanding a Lee mandrel - besides any lack of uniformity due to human error - is that the area of the mandrel held in the drill cannot be sanded. You cannot flip the mandrel due to its shape. Because of this, the bottom of the mandrel (just above the decapping pin) may become like an expander button, exerting drag as you try to extract the case from the die. Fortunately, this drag is light and does not distort

the case (ruin concentricity) provided no serious mistakes have been made and the mandrel is not grossly undersized at the area of the case neck. Having said all of this, the optimum fix is to order an undersized mandrel from Lee - yet another service Lee happily provide. Nevertheless, experimentation with an existing mandrel can help the handloader decide on the correct mandrel diameter before making a purchase from Lee.



Sanding the Lee neck sizing mandrel.

Please bear in mind that with a wide chambered rifle such as the 8x57 example, the neck sizing process does cause a degree of lost concentricity, resulting in run out of 2 to 4 thou - right on the limit as far as optimum accuracy is concerned. Some of this can be remedied with neck turning to give the cases a “best possible” start in life, but I dare say few people would be interested in neck turning for the old 8mm. To be brutally honest, with a concentricity gauge ammo of this nature can be

bent back to true. Even thumb pressure can true ammo made with a Lee die if the neck tension is not set immensely tight. Please see the problem solving and advanced reloading section of this book for more details on these subjects.

To set up Redding neck bushing dies the first step is to obtain the correct bushing for neck sizing. This in itself can be a problem as Redding bushing dies are available in a wide range of diameters, the typical variation being 8 thou from the small option to the widest. Redding suggests that a dummy round is made up and measured. This basically involves taking a new case and seating a projectile (omitting the first neck sizing prep step). The outside diameter of the neck of a dummy cartridge should then be measured and a bushing selected which is 1 thou smaller than this measurement. But the fact is, few people are willing to purchase dies, then make up a dummy round, then send away and wait for an appropriate bushing. It is certainly a lot easier if you have a Redding dealer close by, not so easy if you live hundreds or even thousands of miles from a Redding dealer.

Close up of a Redding bushing. Note also the optional expander button. I prefer to avoid this route if possible.

A simple alternative is to purchase the tightest bushing suggested in the Redding bushing chart. This may horrify Redding who would prefer to see minimal sizing - an important factor to prevent case neck distortion and maintain optimum concentricity. However, the problems of first time reloading and mail order can be overcome by adopting this method. Later, if concentricity is poor, the handloader can select a second bushing for experimentation roughly 1 to 2 thou smaller than the established diameter of loaded ammunition. Neither bushing will go amiss as each can be used for experimentation and comparison. Apart from my suggested approach, the handloader is left to guess (you will need an eight sided dice) or seek advice from existing Redding die users utilizing identical component brass. Again, please understand that my advice is the opposite of that which Redding would offer. To my way of thinking, if neck tension is too loose the rifle may be accurate

but with a poor ES, and any immediate accuracy at 100 yards will soon be lost if shooting long ranges. Furthermore, very loose fit projectiles may shift and change COAL under recoil when in the rifle magazine. I certainly have no disagreement with Redding's suggested neck tension regarding the maintenance of optimum concentricity. All I am talking about here is a starting point without any other information to work with. My ideal is sometimes 1 but often 2 thou undersize.

Once you have your bushing it will need to be fitted to the die. Take the die and remove the end cap / head in order to fit the bushing.

If your Redding neck die does not have a micrometer head, turn the head down until it comes to a stop (touches the bushing), then back off the head a quarter turn to ensure the bushing maintains its float.

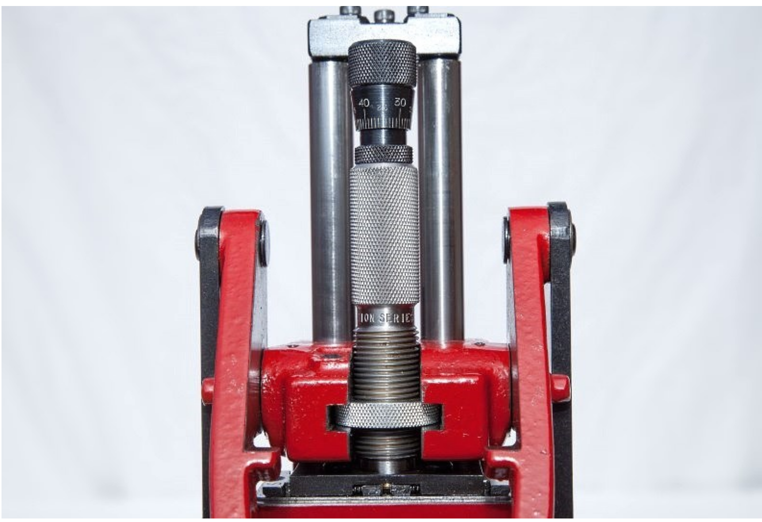
If your Redding neck die has a micrometer head the micrometer needs to be backed off to the number two. Next, remove the entire head from the die (grip below the micrometer), fit the bushing, and then reassemble.

Now loosen the die lock ring and back it off. Following this, insert the die into the press and fit the correct shell holder to the ram. With the ram fully raised, turn the die down until the outer die body touches the shell holder. Some redding dies utilize an inner sprung collet while entry level dies do not. If your die has an inner sleeve make sure you do not confuse the sleeve with the outer die body. Turn the die down until the actual die body contacts the shell holder.

Once contact has been made, back the die body off just enough to prevent any severe compression (a few thou). If your die has

a micrometer head, screw the micrometer down until it bottoms out, then back it off 10 thou. At this point, the die body and inner neck bushing are set as low as possible without pinching the bushing or posing any risk of damage to the die.

Redding recommend rotating the die so that the micrometer (on micrometer models) is front facing. Personally I like to have the die as close to the shell holder as possible, so I tend to ignore this aesthetic aspect. In actual fact, I do not fully understand the point of the micrometer on the neck sizing die. The Redding die fails to size all of a case neck to begin with, so I do not see any merit in a micrometer which only allows less of the neck to be sized instead of more.



A case being neck sized utilizing a Redding die mounted in a Forster press. A Forster lock ring must be used as the Redding lock ring is too small and produces too much play in the press housing. Note that the micrometer is not set to any particular orientation.

Once the die is set in place, the locking ring needs to be set and tightened. The final step is to check that the decapper is not set too low. If it's too low it will become crushed and bent during sizing. The height of the decapper can be adjusted via an allen screw in the die head. Set the decapper so that the pin only just passes into the shell holder - just enough to expel a primer. And finally, as Redding states, adjusting the micrometer of a micrometer fitted neck die also changes the position of the decapper. So again, make sure the micrometer is wound right down, then backed off a minimal amount.

Once the die is set in place, use a dry graphite lube to lubricate case necks. You can now run your cases through the die. Just remember that this die does not size all of the neck. You may feel that you have made a mistake somewhere, however the partial sizing is normal for this particular die.

If you are using a traditional type neck sizing die without a collet (e.g. and especially Hornady), select the correct shell holder, then place a case in the shell holder and raise the ram to its top most position. We must start with a case in the shell holder, because if the die is generic such as the nomination 7mm rather than being designed for a specific cartridge such as the 7mm Remington Magnum, the die body will have been made to suit short through to very long cartridges.

Next, take the neck die and remove the decapping rod from the die and make sure the lock ring on the die is also loose and backed right off to the top of the die thread.

Now screw the die into the press until it touches the <u>case mouth</u>, then lower the ram / case and turn the die in another turn.

Following this lubricate the outside and inside of the case neck and run the case into the die. After extracting the case, observe how much of the neck has been sized based on the ‘tide line’ of lubricant on the neck. If the entire neck has not been sized, turn the die in a quarter of a turn (or less) and retest. Continue this process until the case neck is sized to the shoulder, without impacting the case shoulder. If the case shoulder is impacted, it may become distorted and the case body diameter expanded. This could ruin accuracy and / or make feeding difficult. Once you have established the correct height you can set the lock ring in place.

Setting up a generic Hornady neck sizing die. Note, the die is backed right off. The decapper assembly has also been removed.

Close up of the previous photo. The neck is partially sized, showing a graphite tide line.

The case is now neck sized to the neck / shoulder junction. If in doubt it is best to size to a point a fraction above the junction rather than sizing too much of the neck and crushing the case shoulder. Also be aware that Hornady offer two distinct types of "generic" neck die. For example in 7mm, Hornady offer a "7mm neck die" but also a "7mm Magnum neck die". The Magnum neck die is designed for the RUM and WSM Magnums and also has a sharp 30 degree shoulder. The traditional 7mm neck die is suitable for the 7mm-08 through to the 7mm Remington Magnum. If you are building a wildcat with a sharp shoulder it can pay to use a Hornady Magnum neck die rather than one of Hornady's traditional neck die.

The case on the left has been crushed in a Hornady neck die and shows an impacted shoulder (note the convex shape). You can even see a height difference between the two cases. The case body diameter has also widened. This case will need to be full length sized to reduce its body diameter (otherwise it will not chamber), then undergo a fireforming phase.

The next job will be to set the decapping pin in place. The reason I asked you to remove this during the set up phase was to prevent you from making a mistake while being focused on the case neck. Many times a handloader has been so focused on the case neck that he fails to observe the decapper coming down with the die. If it comes down too far the expander button on the decapping assembly will be jammed against the bottom of the case, bending and potentially ruining the decapping assembly. Bugger!

When fitting the decapper its tip (pin) should only just protrude into the shell holder - just enough to eject spent primers. We

may have to adjust this again during round two when we reload our fireformed brass. But for now the decapper will be set safely, allowing the expander button to perform its task of expanding the case neck to an optimal diameter.

The decapping pin is now set in place without risk of the button being compressed against the bottom of the case.

Once the neck die is fully set up with the decapper in place, run your case through once again. But this time observe resistance as you draw the case out of the die and over the neck expander button. Make sure you utilize plenty of lubricant for this task. If resistance is very high, the case will be pulled and extruded to the point that it may be difficult to chamber the cartridge in the rifle. Concentricity and accuracy may be seriously compromised. Overworking the case can also lead to problems later on, the brass becoming work hardened and in need of annealing.

If you have found that extraction of the case from the die is very difficult regardless of lubricant, you may need to polish the expander button. This is however a tough call for those new to reloading. It is important to understand that problems encountered may stem from operator errors such as poor technique when applying lube. If however you have exhausted potential faults, you may find that you need to polish the expander button. Here we have to be very careful to remove only a small amount of material when polishing, otherwise the neck may be made too tight. If the neck is too tight, concentricity may be poor during bullet seating operations as the bullet is forced into the case neck.

To polish the expander button remove the decapper assembly and chuck the assembly in a drill. In your other hand you will hold a small section of sandpaper. This will enable you to spin and sand the button to a smooth finish. If the button is very coarse you may need to start with a six to ten second burst using 180 grit sandpaper before moving to a short burst with 240 grit sandpaper and a longer burst with 320 or 400 grit sandpaper. Finish with Autosol, JB paste or a similar high polishing paste product on a small section of rag, being careful not to tangle the rag when operating the drill. When sanding make sure that you pass the sandpaper up and down the button. If you just let the drill spin with the sandpaper sitting in one place, the sandpaper may simply follow existing machine marks without cross cutting and removing them.

As a final step you will need to check and make sure that your first case can be chambered and extracted from the rifle action without difficulty. It can be awkward to get a case to feed from the magazine without a bullet seated in the case, but with careful manipulation a case can be fed into the chamber. The

M700 and similar type actions are the easiest: simply dump a case in the chamber and close the bolt. But if testing an action with a claw extractor such as the Mauser or Winchester Model 70, you must be very careful as to how you place the case: make sure the extractor goes over the rim of the case before the case is fed into the chamber. Otherwise you may break the extractor if its angles and finish are not optimal.

Make sure the claw extractor engages the rim of the case when testing case feeding in rifles with claw extractors. The case must not sit forwards of the extractor during testing, otherwise the extractor may break when trying to snap over the case rim.

Summary of Key Points:

- Fit correct shell holder.
- If using a collet or bushing type neck die (e.g. Lee, Redding), follow the manufacturer's instructions.
- If using a traditional type of neck sizing die, remove the decapping rod from the die, loosen and back off the lock ring.
- Screw the traditional die into the press until it touches the shell holder, back off one turn.
- Lubricate the outside and inside of the case neck and run the case into the die.
- Alter die depth until all of neck is sized without impacting the shoulder (check in chamber if unsure).
- Set lock ring in place.
- Fit decapper in place.
- Commence sizing brass.

Full length sizing new brass or donor brass

There are several cases when we will use full length sizing dies:

- If you do not own a neck die.
- When handloading for gas, pump, Blaser or lever action rifles that may jam with neck sized brass.
- If you have obtained once fired brass from another rifle to be used in your rifle.

- To resize brass that has been neck sized several times and is now too tight to chamber smoothly.

The process of setting up a full length sizing die is much the same as setting up a neck sizing die. However, with a full length sizing die we can do a lot more damage to brass and ruin accuracy if we do not pay close attention. If the brass is made undersized, the constant working of brass may cause a head separation (case splits just forwards of the rim) after only a few resizings. Neck temper can be ruined requiring premature annealing while the cartridge may display poor bullet to bore alignment (concentricity).

Again, make sure the lock ring of the die is loose and backed right off. Make sure the decapping assembly / spindle is completely removed from the die.

Turn the die into the press until it touches the shell holder. Now turn the die out a full turn.

Apply lubricant to a case, size the case in the die, and provided extraction from the die was smooth (if not - lubricate and try again) chamber the case in your rifle to check its fit.

When chambering a case in your rifle, be gentle. The brass may still be a poor fit. Or it may be part way through a process where the die has narrowed the case body diameter but in doing so has made the case longer. If you try to force the case into the rifle, it may create a jam. If you do jam your rifle, you may have to run a cleaning rod down the muzzle until it enters the case, then gently tap the case out. If you have a doozy of a jam, you can also have someone gently tap the bolt back with a wooden mallet at the same time. But make sure the bolt is fully up and not half cocked. Please understand that such practices

are fraught with problems and can result in breakages. Be gentle - extremely gentle!

You will need to keep repeating the sizing and checking process, turning the die down until the brass cases feed smoothly in your rifle without being made grossly undersize. If the brass is new, this will hopefully be a very simple one step process where the brass feeds smoothly even though the die is backed out of the press one full turn.

Once you have your cases feeding smoothly and the die locking ring set in place, you can fit the decapping assembly. Set it to a height where the pin just passes into the shell holder by a few millimeters (perhaps 80 thou). If you go too long the button will crush into the inner case and bend the spindle, possibly ruining the assembly. Next, feed a case into the die again and check that the expander button allows for a smooth extraction of the FL die. You should feel a degree of resistance, but not so much so that you have to muscle the case out of the die with great force. If you discover high resistance over the expander button (despite having made sure to lubricate the inner case neck properly with a cotton bud), then you will need to sand and lightly polish the expander button as described during the neck die set up process. If you do not address this problem, whether it is caused by operator or component error, the brass will be stretched, overworked and may not chamber in your rifle.

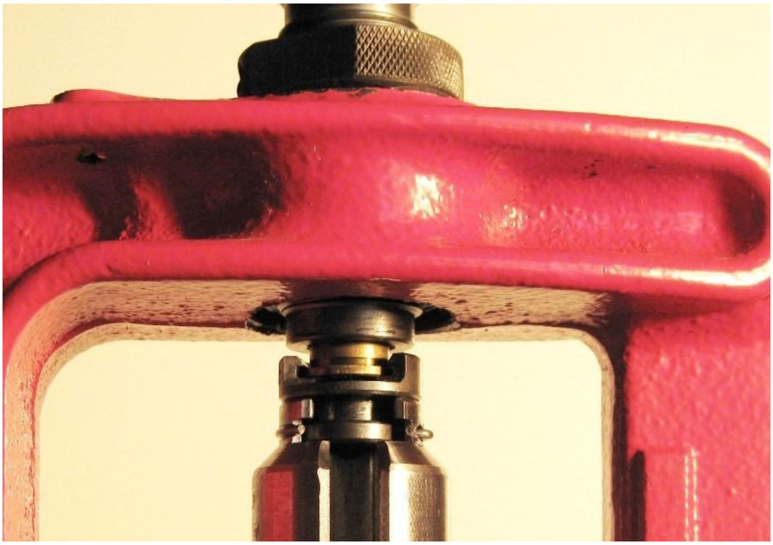
The expander button is a real trap for new players. The traditional method of setting up dies is to leave the decapping assembly and expander button in place. The trouble is, folk who are new to reloading can be overwhelmed by all that is happening. It is easy to overlook the fact that the button may

be too low or that the button is gripping and stretching cases. This is why I recommend a two step process.

The other traditional set up process that I do not recommend is to simply screw down the FL die until it touches the shell holder and to then set the locking ring in place without any experimentation. This is especially bad when handloading rimmed cartridges such as the .303 British, .30-40 Krag and .30-30. Many such rifles have quite generous headspace, and if the brass is sized to minimum dimensions the cases will stretch a long way forwards during ignition before the shoulder of the case makes contact with the shoulder of the chamber. The continued process of making the cases vastly undersized, followed by stretching during ignition can lead to case head separation. The cases work harden and become both thin and brittle at the case head; ultimately they split just forwards of the case rim. This can result in a stuck case, where the rim comes away during extraction of the case from the chamber, leaving the body of the case jammed inside the action. If this happens, the rifle may need to be taken to a gunsmith to have the case body removed from the rifle.

A .308 Winchester case displaying partial case head separation from continually being made too small in a full length sizing die, then having to stretch forwards to fill the chamber each time it was fired.

A lubed .303 British case being presented to the die.



Sizing the .303 British case. Note the gap between the shell holder and case.

The case is now sized. You can see lubricant has come down to the shoulder but the shoulder is not impacted, the lube is still proud. The case is now head spacing off the case shoulder rather than the rim, and this will help minimize any risk of case head separation

Summary of Key Points:

- Fit correct shell holder.
- Set up die.
- Be careful not to crush decapping assembly.
- Apply lubricant to cases if lubricant is required (avoid shoulder).
- Make sure inner and outer neck are lubed.
- Size the case - make sure it extracts smoothly from die without great force.
- Size brass.

Using a full length die as a neck sizing die?

This is another trap I have seen handloaders fall into. The theory goes that by backing off the FL die a touch it can be used as a neck sizing die. There is a problem with this method. Sometimes, if the FL die is of very tight dimensions and the rifle chamber is of very wide dimensions, the slightly backed off die may severely reduce the body diameter of the case and also stretch the case, thereby making the case longer and shifting the shoulder forwards. The handloader continues to turn the die down in 1/4 or 1/8 steps until the shoulder dimensions are reduced and the case fits snugly into the chamber with a measure of feel and declares the case as being neck sized with an FL die. But to achieve this, the case was first extruded, then crushed and moved from pillar to post before appearing to be "neck sized". All of this stress and strain can work harden the brass and also ruin concentricity. On the other hand, if you have a rarer cartridge for which you cannot readily obtain a neck sizing die, this method may be your best option.

By turning the FL die down in small increments the handloader can find a position where both the case body and shoulder dimensions are reduced just enough for smooth feeding. Going just past the point where there is a measure of feel on the bolt handle to the point where cases feed easily without being grossly undersized. In some rifles, full length sizing dies used in this manner can at times produce ammunition which is just as accurate as neck sized ammunition, but often the results are poor. Much depends on the individual reloading die tolerances. Redding Type S full Bushing dies can be especially useful in this regard, minimizing case distortion and optimizing concentricity.

If an FL die is of more generous dimensions, then it may be used for partial sizing with more positive results than that achieved

by a tight bodied die. This is still not quite the same as proper neck sizing but can still be very useful; in some cases it is the sole option if neck dies are not available for a particular cartridge. The .303 is a good example - neck dies are not common for this cartridge. Fortunately the .303 British case design has a good deal of body taper which helps prevent cases being extruded (made longer) during minimal full length sizing operations.

The main factor I have wanted to cover in this section is that a backed off traditional full length sizing die is not the same as a neck sizing die. This does not mean that you should not use an FL die in this manner. All I wish is for you to understand the differences and potential consequences.

Summary of Key Points:

- Some full length dies distort the case too much to be used as neck dies.
- Loose tolerance full length sizing dies can sometimes be used for neck sizing without too much case distortion.
- Redding full bushing die useful where a compromise is required.

6. Size your brass

Once you have set up your neck or full length dies and first few cases, you can now proceed to size the rest of your brass.

Make sure cases are properly lubricated if they are to be used in a die that requires lubricant (see individual die instructions). Next, try to focus on uniformity of your actions, avoiding force or jerky motions.

I tend to wipe each case as I extract it from a sizing die, removing any lubricant from the outer body, outer and inner neck. If I am using wax lubricant, I remove this from the inner case neck with a cotton bud. I change cotton buds about every three cases.

7. Trim and chamfer brass

Whether you are using new or recycled brass, it is best to trim the brass prior to fireforming or preliminary load development. After this you will need to check the length of cases each time you reload in order to make sure they are not too long, which could result in dangerous pressures. Unless the cartridge is a wildcat (custom design), maximum case lengths are generally set by SAAMI (USA) and CIP (Europe). If no information can be found on maximum lengths or trim lengths, new brass should be measured and recorded as being the maximum length, then trimmed 10 thou or .2 to .3mm shorter. The Lee trimming system utilizes pilots preset to industry standard case lengths. That said, it can pay to double check to see if the pilot is allowing cases to be cut to the appropriate length.

New cases. The case mouths are irregular and heavily burred. After sizing these cases need to be trimmed and chamfered.

I tend to use the simple Lee trimming system with a cordless or even a corded drill, then chamfer the inside and outside of the case. One word of advice here, and this applies to all brands of trimmers: replace your cutter before it gets too blunt. A very blunt cutter can have negative consequences, besides taking a great deal of force. The trim lengths can end up quite uneven from case to case, with a variation of around .2mm or 10 thou or even more. The same goes for chamfer tools: replace as necessary to avoid undesirable results.

Trim cases, then chamfer, then polish the case mouths with a poly pad.

During the chamfering process remember to make sure that the case is chamfered more on the inside than the outside. If you have new cases which have a bur on the outside you may need to offset the angle of the chamfer tool slightly. That way the bur is removed without putting a full chamfer on the outside of the case, which in turn could shave copper from projectiles.

Note that the chamfer on the inside of the case neck is heavier than the chamfer on the outside of the case neck.

Once the case is chamfered, I polish the case mouth with a poly pad and / or a white mounted point to dull off any sharp edges. After this I also polish the outer body of the case with the poly pad as required.

Summary of Key Points:

- Trim and chamfer brass after sizing.
- More chamfer on the inside than the outside.
- Remove sharp edges with a poly pad etc.

8. Clean and or uniform primer pockets

If you are new to reloading and using new brass you may wish to avoid any special preparation here. But if you are using previously fired cases you will need to clean the primer pockets. Following this, you can move on to priming the cases.

Once fired Winchester brass. I have used my Lyman primer pocket uniformer to remove carbon and uniform the pocket.

Those of you who wish to pursue extreme accuracy will want to take some extra steps now. As previously explained, there is a difference between a basic primer pocket cleaner which simply roughs out carbon deposits and a primer pocket uniformer which cuts the pocket to a precise depth. A uniformer can be used for primer pocket cleaning but if the tool is expensive, it is best to refrain from such practices and use the tool as it was designed. To this end, I tend to use my Lyman uniforming tool

for generalized cleaning and uniforming, while my K&M tool is utilized only during initial brass preparation when I am handloading for extreme accuracy. If the brass is once fired donor brass, I clean the pockets first with the Lyman tool, then uniform them with the K&M tool for absolute precision. The K&M tool also has somewhat more heft to it, and I can chuck it in a cordless drill to save time. Once brass is prepped with the K&M tool, I use the Lyman tool or Hornady Prep Center tool.

For whatever reason every now and then I come across a batch of Norma brass with very small (tight) primer pockets. Occasionally clients report the same. The usual joke is made, that brass prep will involve a hot load to loosen the little buggers. A tool like the K&M can be very useful in such cases, as without a tool of some heft the primers really have to be rammed home. And even after applying brute force, the primers still protrude, bordering on unsafe handling conditions. Nevertheless, it always surprises me what a primer can be put through, wedged and forced into place.

Primer pocket uniforming cannot turn a 3 MOA rifle into a sub MOA rifle. The finer steps of reloading often account for only around .1 MOA, with multiple steps accounting for what is best described as fine tuning accuracy and ES.

After the primer pockets are cleaned and uniformed I move on to flash hole deburring and uniforming. You do not have to be at your reloading bench to do this particular job. If you want to you can spend time with family or friends while gradually working through cases.

Having uniformed the primer pockets and flash holes, the batch of brass is now ready for loading and fireforming - with great

confidence in the fact that efforts have been made towards good case preparation.

Summary of Key Points:

- Clean and / or uniform primer pockets before priming.
- Beginners may skip cleaning or uniforming if using new brass during first round of reloading.

9. Flare case mouth (straight wall cartridges only)

If you are handloading for a pistol cartridge such as the .357 or .44 Magnum or handloading for a straight walled rifle cartridge like the .444 marlin or .45/70, you will need to flare the mouths of your cases. Your die set for these cartridges should consist of three dies, a full length sizer, an expanding die (case mouth flare) and a seating die which can also perform crimping operations. If you do not flare case mouths, there is a risk of crumpling the case mouth during bullet seating. Any doubled up case material will make chambering difficult and could cause dangerous pressures, so this step is very important.

To set up a generic case expander (e.g. RCBS) raise the ram and shell holder to their highest positions. Take the die, loosen the locking ring and back it right off. Next, turn the die in until it

touches the shell holder, then turn down the locking ring and set it in place.

Back off the expander mandrel to a point where it is only just engaged in the die.

You may need to lubricate the inside of the case (approximately a quarter inch) with a cotton bud and wax lube or graphite. If in doubt and in lieu of manufacturers' instructions, use a lubricant - at least to begin with.

Place a case in the shell holder and run it into the die. Next, turn the expander mandrel down until it engages the case mouth. In some cases (such as RCBS) the spindle may have two steps. The first step simply aligns the case, the second step or bump flares the case mouth.

You will need to back the case out of the die, then turn the mandrel down in small increments until the case mouth is flared. After this, the spindle lock nut can be set in place.

When flaring case mouths, the mouth should be opened up only at its very tip and only by a very small amount - just enough to locate the projectile. If cases are flared too heavily, bullet grip may be poor or the case may end up too large for the rifle chamber and may need resizing. That said, crimping during seating can remove most of these ills.

Some dies do not require lubricant, others do. Again, if you do not have any manufacturers' instructions, use lube to begin with. If friction appears to be very low, you can gradually reduce lube. If your die does require lubricated cases, you may prefer to perform case mouth flaring immediately after sizing, so that you only have one lube clean up step rather than two. Please

remember that if you trim cases after flaring, the case trimming operations may remove the case flare.

An RCBS expander die. The .45/70 case shown is lined up correctly (height) with the expander mandrel. The case passes over the mandrel (right), then slides up until it hits a step mid way up the mandrel which flares the case mouth.

Subtle flaring of the case mouth.

Summary of Key Points:

- Flare case mouths when handloading straight walled cases.
- If no die instructions are present, use a lubricant on the inside of cases during initial set up to prevent stuck cases.
- Avoid heavy flaring.

10. Prime cases and fill with powder

This is a relatively straight forwards subject, whether we are using a basic press priming system or hand priming tools. The same rules and methods apply to both beginners and advanced users without any extra tips or steps.

I flip all of my cases over, so that the primer pockets are upright as they sit in the reloading block. If you have a shallow tray, you may not be able to do this. With the cases upside down I can check that each primer pocket is indeed clean, and the system of priming and flipping the cases back to their normal upright position in the block helps ensure I won't miss priming any cases. If the cases stay unprimed, the mistake often goes unnoticed until it's time to seat the bullets. When hello, powder begins to dribble out of the case. Do not try to prime cases after this has happened, as the situation will go from bad to worse. Pull the loads and start over.

Handle primers with clean and dry fingers. If you are sweating, you may need to use latex gloves. Hold primers at their sides when handling.

Consistency is the key factor during priming. Apply the same pressure to each case during priming, seating the primer to the bottom of the primer pocket.

The correct seating depth for primers is just below flush, firmly seated against the bottom of the primer pocket without any protrusion. Sometimes with new brass this can be very difficult to achieve, especially if you have not used a primer pocket uniformer. The crudest method of checking that the primers are seated flush at the very least is to simply place the case upright on a flat bench. If the case wobbles, the primer is protruding

and needs to be set deeper. If a good deal of force has to be used, so be it. Try to gain some degree of muscle memory as you prime tight cases, again working towards optimum consistency and depth - either flush or optimally, a few thou below flush.

Ensure primers are not protruding after seating. Ideally, the primers should sit just below flush.

If you are called away from the bench after priming (or during powder charging), you will need to put your primers and primed cases away to prevent any moisture gathering on the primers. Use either zip / snap lock bags or a good plastic container. If the cases are in the block and you are part of the way through powder charging, carefully wrap the block and cases in cling film. You will need to take great care not to bump any charged cases as powder has a great habit of jumping out of cases with minimal vibration.

Once the cases are primed, you can proceed to powder charging. To begin with, set your scales to zero. Once the scales are set to zero remove and replace the pan a few times to check that the bearings are moving freely and that everything is repeatable. When you have a consistent zero, you can set the scales to your start load.

Double check that you have the start load set correctly on your scales.

Select your powder and look the tin over closely to make sure you have the right powder. Many a rifle has been destroyed by a tired handloader selecting the wrong powder because the labels or colors looked somewhat similar. Do not write on the lid of the powder (such as “my .308 powder”). You may accidentally swap lids by accident. Don’t laugh, it has been done before.

Make sure you only have one tin of powder (the powder you intend to use) on your reloading bench to prevent mix ups which could produce dangerous consequences.

The next trick is the big secret. If you are using scales as opposed to a dispenser, you need to find the right teaspoon. Yes, that’s what I said - the right teaspoon, something that feels just right in your hands that you can wield like a samurai sword. I use a KFC spoon from the 1990’s - it’s red. Its weight and capacity are perfect, neither too little nor too much. If I use another teaspoon, I struggle. One day this teaspoon will perish and break. But for now, my KFC teaspoon (the old mashed potato and gravy teaspoon) is my weapon of choice. I tell you, I am always vigilant when it comes to plastic teaspoons. If we are passing through some place and pick up fast food - my eye is always drawn to teaspoon potential. Seriously though, a good

teaspoon can help speed up the process of powder dispensing. A light teaspoon is best for feel - hence the suggestion of plastic. Lee powder dippers can also be useful for both volume control and feel.

When performing incremental load work I set up my reloading block so that cases are in rows of three. That way I am less inclined to forget about stopping to change the charge weights and making a mistake.

Weighing out 26 grains of Trail Boss as a fireforming load for the 7mm Remington Magnum loaded with 162 grain bullets.

Summary of Key Points:

- Cases upside down.
- Prime cases and flip upright.

- Be consistent.
- Set scales to correct start weight.
- One tin of powder on the bench at a time.
- Charge cases, rows of three if incremental testing.

11. Seat bullet

Your reloading dies will come with a set of instructions which will explain the set up procedure for bullet seating. It is important to read these instructions carefully, especially if the die exhibits unique design features. The following are some useful pointers to be used in conjunction with this information or in lieu of this information.

To set up the Lee dead length seating die, depress the press handle to raise the press ram and shell holder to its top most position. Next, take the seating die and back off the die locking ring. After this insert the die into the press and turn it down until it touches the shell holder. Following this lift the press handle to lower the ram, then add an extra quarter turn to the die. You can now depress the press handle again so that the shell holder comes up and makes full contact with the die. The final step is to set the lock ring in place.

After the Lee seating die is set in place the bullet seating stem, which controls how deep the bullet will be seated, needs to be backed right off. These are sometimes a bit stiff as delivered from the factory. But don't be shy - if it needs to be cracked, use poly grips (and padding) to grip the seating stem (very top of

the die) and break the freeze. Then back the stem off until it is almost out of the die.

Finally you can set about bullet seating. Start by placing a charged case and projectile into the shell holder. Depress the ram until you feel the bullet just starting to enter the case. I sometimes jiggle the press handle sideways to help align everything. Once the bullet has just started, raise the press handle slightly, rotate the case and partially seated bullet, then continue to seat the bullet home. Rotating the case and bullet will help ensure optimum concentricity. The bullet should not be far into the case neck because the seating stem has been backed off. You can now set about turning down the seating stem, working towards your correct COAL. As you get closer to your COAL (within 1mm / 40 thou), you will need to turn down the stem in smaller increments until you are turning it down in 1/8th and then 1/16th increments.

You can now continue to seat bullets into your batch of ammunition. Seat, partially extract, rotate, seat home. Job done.

To set up a Redding micrometer style seating die, loosen the locking ring on the die and back it off. Back the micrometer off until it reads 2. Next, fit the die in the press, then turn it down until the outer die body touches the shell holder, then back the die off so that the micrometer ladder markings are front facing. Next, set the die lock ring in place. The seating die is now ready for use and the micrometer can be turned down incrementally to adjust bullet seating depth. As with Redding's micrometer neck die, it is not critical that the micrometer markings are front facing (see picture).

A Redding Competition seating die. In this instance the micrometer has been utilized for precise seating, however the die is not set up in such a way that the micrometer ladder hash

marks can be read. Instead, measurements are based on the COAL reading rather than inspection of or reliance on the die setting.

Many traditional seating dies have an internal crimp feature which is sometimes best avoided, unless you are loading for pistol, lever action and some gas operated rifles where the action mechanism causes a great deal of inertia within the magazine during cycling. Very potent cartridges can also require crimping, if recoil is so high as to cause projectiles to be pushed further into the case. Both, gas operated and high recoiling cartridge / rifle combinations can be tested on a rifle to rifle basis. Observing the behavior of loads within a magazine will soon tell you if crimping is necessary.

To set up a traditional generic type seating die for both seating and crimping take an empty case and place it in the shell holder, then lower the handle to raise the case to top dead center. Next, take the seating die (locking ring backed off) and wind the die in until it stops against the case - without forcing the case and press handle down. Extract the case, then turn the die in another quarter of a turn and set the locking ring in place. The die is now set to crimp (fine tuning may be needed). Following this, back off the bullet seating stem and place a projectile and charged case into the shell holder and start the cartridge into the die. If you need to, you can use a dummy round for experimentation. Finally, wind the seating stem down incrementally until the desired seating depth is obtained. The Lee crimp die from the Ultimate die set is discussed separately within its own chapter (see crimp die experimentation).

To set up a traditional seating die without crimping screw the seating die down until it touches the case mouth, then back the

die out. I usually back off two turns to play it safe. Following this, set the locking ring in place and back off the seating stem. The current Lee Ultimate seating die can be wound down until it touches the shell holder, then turned down another quarter of a turn as per the manufacturer’s instructions. This die will not crimp cases, as Lee uses a separate crimp die for their Ultimate die set.

You can now take your pre-measured and recorded projectile and set about seating it in a case.

Begin bullet seating by holding the case and projectile between your thumb and index finger. Then place the case and bullet in the shell holder and maintain this pinch grip for as long as possible, as you push down on the press handle and raise the ram. Seat the bullet a short distance into the case neck, then remove the cartridge and check the COAL to see how close you are to your final COAL.

Adjusting the seating stem on a Hornady seating die.

As you get closer to your final COAL (within 1mm or 40 thou), it is important that you wind down the seating stem in smaller increments: quarter turns at first, then eighth turns as you get closer to your final measurement. Make sure that you fully depress the press handle each time, taking the ram through to its cam over or stop point at top dead center.

Remember, you will not be seating to the maximum COAL, unless you are trying to deliberately jam bullets into the lands for fireforming or target shooting. I do not recommend this for hunting rifles. Your journal has both, the maximum COAL you wrote down plus your proposed test COAL. You will be seating bullets to your proposed test COAL.

If you seat bullets too deep and make the cartridge too short, in lieu of using a bullet puller this load can be used as a fouling

shot. Put the load aside, find another projectile of the same length and start over.

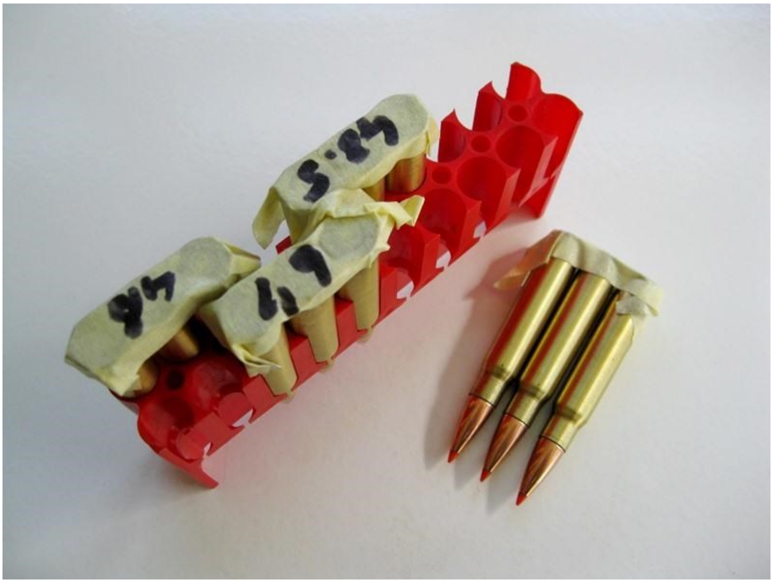
Once your seating die is correctly set up, you can commence seating the entire batch.

Use your thumb and fingers to present the case and bullet to the seating die.

A common practice for concentric loading is to seat each bullet only a short distance into the case, then back the cartridge out of the die a touch and rotate the case 180 degrees. This allows the die to set the bullet straight if initial seating occurred at an incorrect angle. If you wish to adopt this method, I suggest that you retract and rotate the cartridge 180 degrees the moment resistance is felt - just as the bullet starts into the case neck.

Then you can commence full seating unless you wish to continue to retract, rotate and seat incrementally.

For incremental load development I take each set of three finished rounds and either write on the cases with marker pen before placing them in a cartridge holder or tape the three cartridges together with masking tape and write on the tape. If taping, don’t go heavy on the tape and make sure it is easy to tear off (tear tab). Also ensure that the ammo is stowed in something like bubble wrap (in lieu of the ammunition being stowed in a hard case) to prevent projectiles being knocked out of alignment. You may wish to develop your own system. After the ammunition has been identified, you can then move on to seating bullets into the next three cases. All I wish to promote here is that you develop a system that helps avoid mistakes, which may cause a great deal of confusion and frustration during test shooting.



Make sure your ammunition is labeled in some manner if performing incremental load development.

If your first batch of ammunition is loaded with Trail Boss powder with the intention of fireforming cases, you may wish to seat bullets to touch the lands provided the rifle throat length allows this. Seating the bullet into the lands can help align the case for fireforming.

Summary of Key Points:

- Decide whether to set seating die for seating or seating and crimping (if die performs both operations).
- Set die in press, turn down until either touching the shell holder, or with slight

clearance if not crimping (see die instructions for specific details as to whether your die crimps).

- Set lock ring in place.
- Back off seating stem.
- Place case and bullet in die and start seating.
- Wind down seating stem until desired COAL is achieved.

12. Test fire ammunition

You can use your fireforming loads to break in your barrel if you wish to. If the rifle is unfamiliar to you, you can use this period as an opportunity to get to know the rifle.

Safety glasses are a must, especially when testing new, unfamiliar rifles. I have to be honest here and state that I only wear safety glasses at certain times. I have found that safety glasses can reduce eye relief - the scope bashing the glasses and they in turn hitting my eyebrow - if shooting heavy recoiling rifles. This can lead to flinching. Shaded safety glasses also tend to obscure target vision. I do however wear safety glasses when testing anything unfamiliar. There are risks both ways I suppose. I can tell you that I have never seen a shooter wearing safety glasses when hunting, though this is sometimes seen in the U.S. I simply want to be honest here as opposed to hypocritical. Ideally we should wear safety glasses. Also, while I have talked about flinching from “Weatherby” eyebrow, beginners may feel much safer and flinch less when shooting with safety glasses

unless the rifle is very high powered or the scope has very short eye relief. One fact that has to be understood is that if you get your loads wrong (e.g. wrong powder), there is a chance of severe / permanent eye damage unless gases or shrapnel (including scope shrapnel) are directed away from the eyes.

Please make sure you wear good hearing protection, either class five ear muffs or class five ear plugs. The lower grade earplugs (three is a general hardware store type ear plug) are particularly bad. They seem OK at the time, but if you are shooting regularly, you may eventually still suffer from hearing damage or tinnitus.

If you are performing preliminary load testing, you can focus on good shooting technique without putting yourself under a great deal of mental pressure, as these are not your final test loads. Focus on optimum accuracy without any great or unrealistic expectations.

As I have continually reiterated throughout my published work, use sandbags during testing and avoid the silly crossed arm shooting position which has been in vogue now for several years. If using a shooting bench, make sure the bench is sturdy and does not sway. If you do not have access to a sturdy bench, lie down and shoot prone over sandbags. I hope to write a full book on shooting technique and field work in the near future, as there is a lot to say about these subjects. So, I will say little more here, other than to reiterate that you need to use a sling and a good traditional forend hold during shooting. Hopefully you have followed the previous books in this series and performed any rifle accurizing steps and trigger modifications that might have been necessary for your individual rifle.

Take your time during test shooting - it's not a race. Make sure you have your journal and pen at your side to take notes and for the recording of chronograph readings. Wear clothing appropriate for the season (sunscreen in summer), and take plenty of liquids (the non-alcoholic kind obviously). Wear a hat, preferably a boonie style hat. During test shooting you need to be in a relaxed state of mind and committed to spend the time required to get the job done properly. Do not drink power drinks, these could give you the shakes.

Keep your barrel cool. Be especially careful if you are working up loads for an ultra light barreled rifle such as the Tikka T3. Warm is OK, but a hot barrel is a no-go! All you will do is wear out the throat and suffer fliers, as the barrel wanders with heat. During incremental load development you need to allow a good two hours to fire off around twenty four rounds. Keep this number in mind when planning range trips.

Rifles at the ready, journal at the ready - and a small pocket radio to keep me company.

If you are using full charges of Trail Boss powder for fireforming, sight your rifle to print roughly four to six inches low (or one mil dot low) at 100 yards. High power loads will then print about two to three inches above the bull during the next round of testing. There may of course be variations of this, depending on the cartridge used; the figures here are simply basic guidelines. In either case, take note of the differing points of impact between your Trail Boss loads and future loads. If you one day have young teens who are graduating to center fire, you can use your Trail Boss loads for initial training.

Unless you are shooting a typical short range cartridge such as the .22LR or pistol cartridges, I would prefer to see you shoot at a range of 100 yards or 100 normal paces. If you are a metric user, you will want to shoot at 100 meters (spelt metres

throughout Europe and in her Majesty's lingo) or 100 goose steps (long paces). Of course you could also use a rangefinder to determine the distance to the target. If the rifle has not been bore sighted, you may wish to start at 25 or 50 yards. But as soon as the bullet is printing on paper, step back to 100 yards or meters.

I would prefer to see you refrain from 200 yard / meter shooting during load development, as wind drift and human error are more likely to come into play at these ranges. You can perform such tests later on, gradually stepping out ranges as you see fit.

Be very careful of wind gusts during windy days. Gusty winds can ruin groups, especially when shooting lower velocity cartridges. This can lead to a great deal of disappointment, with loads being blamed when the true culprit is wind. As an example, a .308 Winchester loaded with the 165 grain SST at 2670fps will suffer approximately .77" (inch) drift at 100 yards in a 10mph crosswind, 1.55" drift in a 20mph crosswind and 2.32" drift in a 30mph crosswind. If we shoot on a day with winds gusting between 20 and 30mph, we cannot expect this rifle and load to produce groups smaller than .77". If the rifle normally groups say .3" and we add .77" plus .2" for human error under such conditions, we come to a realistic group size of 1.27". So, please keep an eye on winds if you are looking to shoot sub minute (less than one inch) groups. If possible avoid testing during windy conditions. If you have no other choice due to time constraints, set realistic expectations and be prepared to have to retest loads. Your local weather service provider can also be used (if available) to study local wind conditions and with the aid of ballistics software, you will be able to predict just

what you are up against and whether you really need to call it quits.

To measure group sizes, use your Vernier caliper and measure the groups center to center, so that you are on the same page as other shooters. To measure groups you have two options. Either measure the group from outside edge to outside edge and then subtract the measured bullet diameter from this number or you can simply do your best to line up your Vernier blades to the centers. Always measure the group at the widest shots. Do not measure the two close shots and ignore the outlying shot.

Some of you may have heard experts speak of bullets not going to sleep until a certain range. The word sleep describes a point at which any bullet yaw (wobble) is decreased as a result of the effects of drag. Some folk claim that the only way to test for accuracy is by testing at a minimum range of 200 yards. This is supposedly because some loads may be somewhat accurate at 100 yards with accuracy decreasing at 200 yards, while other loads might be less accurate at 100 yards with an increase in accuracy at 200 yards. This is said to sometimes go as far as changing their order of accuracy if the two loads were to be compared.

Let’s get straight down to it here, a lot of this talk is a complete load of bollocks. People wanting to sound like experts, serious intellectual stuff. Yes, there are such things as yaw and bullets going to sleep. But when I put a rifle together for serious long range work and take it to the range, my goal is to get that sucker shooting so tight at 100 yards that there is no improving on it downrange. Tighter than a fish’s butt crack. Accurate is accurate, and that is that. Let’s say I find a load that shoots a

quarter inch from an unbraked high powered magnum rifle - that's a good result under high recoil. Now let's say that the closest I can get to this with another load is .450". There is no way in hell that .450" load is going to physically change the direction of its flight and do better at 200 yards than it was at 100 yards. That load is going to go around .9", no matter what I do. Even if it does go .7", it still won't beat my other load.

When performing load development you need to be able to set yourself at a distance where the rifle can be properly tested but also a distance where wind drift will not greatly affect results. Most shooters also need to take human error and optical limitations into account. These are great problems which few folk talk about when discussing the testing of loads at ranges beyond 100 yards. Nevertheless, I occasionally hear of shooters who have no choice but to use their local club range which is set at 200 yards or meters, based on the idea of setting hunting rifles for a 200 yard / meter zero. If you are in this position, simply do your best.

Although I have (mildly) expressed my conviction that bullet sleeping can be taken too far, there are times when bullet yaw can affect results. The signs for this are sometimes evident throughout the testing process. If for example the ammunition is not concentric, it may produce an acceptable result at 100 yards. Further out it may steadily decline in accuracy and show greater drop at long ranges than that predicted by a computer software program. The same goes for a finicky bore of poor internal dimensions. Such a rifle may produce fliers with all loads. As an example, let's assume that two shots go into .2" while the third shot opens up the group to .4". Initially the .4" group looks good, but when we go to test the rifle at long ranges we may discover that accuracy is very poor. The real tell

is the increased bullet drop, caused by the bullet's reduced BC which in turn is a result of its continued very slight fishtailing. In either case, whether the handload or the bore is at fault, the bullet has completely failed to "go to sleep".

There is also enough evidence to suggest that slight changes in accuracy can be seen as a result of bullets going to sleep past 100 yards. But don't try to tell me that you found one load that shot .4" and another that shot .7" at 100 yards, yet the .7" load proved better at 200 yards. Because when it comes to extreme accuracy both of those loads will need improvement, before we get into the sleeping bullet game and start talking serious shop.

Summary of Key Points:

- Safety equipment.
- Boonie hat and liquids (no power drinks).
- Use sand bags.
- Take your time.
- Keep the barrel cool.
- Test at 100 yards (or meters).
- Be mindful of windy / gusty conditions.

How to read pressure signs

To begin with we need to understand signs of very low pressure. These can include:

- Primers protruding from cases.
- Sooty case necks.

If a primer protrudes from a case after firing a reduced or Trail Boss load it will be because of excessive head space. Rather than expanding to fill the chamber the brass moves forwards but lacks the inertia to move back again, the primer being the exception. This can indicate the need to have a gunsmith correct the head space, depending on how excessive it is. In some cases rather generous head space is fairly normal; the old Lee Enfield rifles being a classic example - enough room in the chamber to fit a cartridge and a week's worth of snacks. Whatever the case, I highly recommend that fireforming loads are not to be used as a part of experimental subsonic load development. When fireforming with Trail Boss, load the case to the shoulder or higher if the projectile is not overly long.

Sooty case necks are another sign of under loading. Good examples of this can be found in the Remington line of factory ammunition, particularly in the .260 and 7mm08 chamberings. I have seen batches of this ammunition so underloaded that the case neck failed to expand and seal the chamber wall during ignition. This allows gas to escape back into the chamber, resulting in heavy carbon deposits within the chamber. The case neck then acts as a compactor, creating a hard layer of carbon. Over time, the carbon layer steadily reduces chamber dimensions at the neck while steadily raising pressures. If the rifle is suppressed these conditions are made much worse, as I have described in my first book. This is a potentially dangerous affair on the part of Remington. It is ironic that a low powered load, intended to prevent any form of litigation, steadily builds up in pressure over time. Nevertheless, the rifles that suffer from this tend to become extremely inaccurate before they reach critical pressures. The owners are then forced to give the rifle a heavy bore scrub which will remove some or all of the carbon, depending on the awareness of the operator.

Alternatively the rifles get rebarreled or sold. Following this the process starts all over again. Getting to the point: If you are shooting very mild loads and your case necks are very sooty, be sure to give the chamber and throat of your rifle a good scrub after each shooting session.

High pressure signs can include the following:

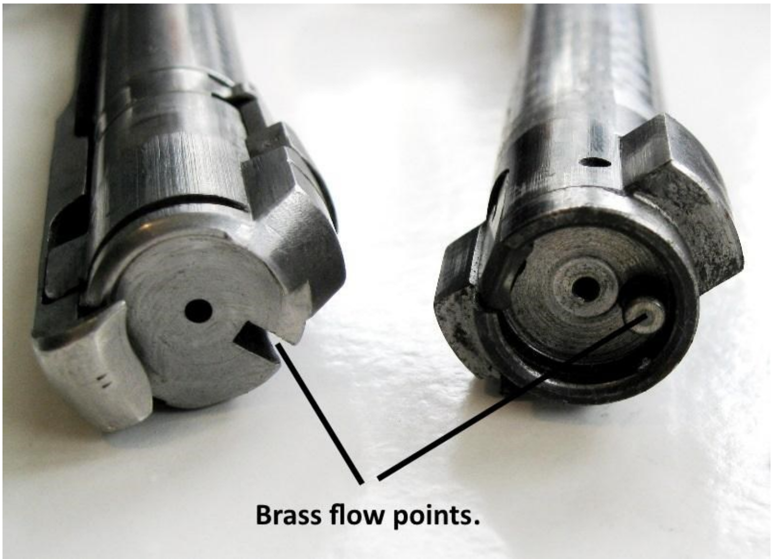
- Extractor marks on the cartridge rim.
- A stiff bolt lift after firing.
- Sticky extraction (following on from a stiff bolt lift).
- Flattened primers.
- Gas leaking at the edge of primers.
- Primers blown out of primer pockets and primer pockets loose thereafter.
- Case head expansion.

The brass and primer are the weakest links in the high pressure rifle system. That is a good thing because the brass will fail before the tougher action steel does. Thanks to this we can use the brass and primer as an early warning system. Having said this, using brass as a pressure indicator in older rifles of inherently weak metallurgy or design is problematic. Beyond a certain point cartridge pressure is unfortunately non-linear. In other words, in older rifles we may be near the point of destruction when brass pressure signs occur - it’s a fine line. So, as I have pointed out in the warning section of this book, this information is applicable to bolt action rifles of sound design and in good condition.

At the range the first signs of high pressures are often (but not always) seen as slight scuff marks or circles on the rear face of the case (but not the primer). These scuff marks occur after the

brass has flowed (been forced) back into the ejector slots or plunger hole of the bolt face. When the bolt of the rifle is lifted the rotating motion can create a scuff mark on the rear face of the case. At other times the mark may simply appear as an indentation. You can study the cut out or plunger hole in your rifle bolt face to gain a better understanding of how these marks are created. Scuff marks or indentations are a sign that you are gradually reaching maximum pressures; with one caveat: some brands of brass are very soft. As an example, Norma and Remington brass can be very soft while Winchester brass can handle higher pressures. Sometimes a rifle will only produce good accuracy at near maximum pressures. In such cases, rather than trying to find a softer load, a handloader may choose to move to a tougher brass.

A scuff mark around the letter G showing initial signs of high pressure.



Brass flows into ejector slots and plunger holes at high pressure. The round scuff mark on the .338 Winchester Magnum case from the previous photo was made by the plunger hole of the Remington M700 bolt on the right. NB# the plunger is depressed when a cartridge is chambered.

Please make sure that you are fully focused when studying brass. Extract the case from the rifle and hold the case in such a way that you can see it clearly, neither too little nor too much light (glare). Study the case closely and look for marks before putting the case down.

Primer stages from left to right: unfired, download (Trail Boss), normal or optimum pressure, nearing maximum pressure (stop here!), maximum pressure (potentially unsafe pressure). In the background sits a Federal .25-06 factory once fired case; its primer shows a small degree of flow but is within safe parameters.

It is extremely important to understand that if you change brass brands loads must be reworked. Case capacities do vary from manufacturer to manufacturer and previous loads may produce excessive pressures in new brass. As another example, I have a batch of Remington .300 Winchester Magnum brass which has around two grains greater powder capacity than its Winchester counterpart, the Winchester brass being slightly thicker. The Remington brass may have more capacity but it is not capable of higher velocities because the brass is softer than Winchester. One factor cancels out the other. The Winchester brass is able

to achieve the same velocities with less powder. Pressure remains the same but the case (being thicker) is more resilient.

It is also very important to be wary of changing between bullets of different design but the same weight. The tougher the bullet the more likely it is to lift pressures. Bullet form and friction are another major factor in the creation of pressure. Yet again, we need to back off loads and start over with testing if changing bullet designs.

The primer is another area that we can use to read pressures. But again, primer strength varies from manufacturer to manufacturer. Winchester and Remington tend to be the softest with CCI and Federal being tough primers. A Winchester primer will flatten before a Federal primer flattens. If a Federal primer flattens, you really are pushing pressures right up! If you are loading for a very old rifle, you may want to use a soft brand of brass and a soft primer, both of which will yield early warning signs of high pressures.

Observe primers by making comparisons between unfired and fired primers. Note how the unfired primers have round edges. Mild loads will retain this round edge, full pressure loads will cause a slight flow and square off the edge. Hotter loads will cause the primer to flow further and an increase in primer diameter will become evident. This indicates the need to back off loads. As loads are increased further (or flat primer loads are used in a hot barrel / hot weather), gas will escape from the primer which is now at the point of failure. The telltale sign for this is soot around the primer pocket. Pressures are now becoming quite dangerous. Complete failure occurs soon after - the primer pocket becomes swollen and can no longer hold the primer. As the case is extracted (normally using a mallet to work

the bolt), the loose primer falls out of the case. The rifle magazine may also be distorted at this point and the locking lugs or action may have been stretched. If the rifle is of an older or weak design, the entire action may rupture. The same can occur if the rifle action is of a modern ultra-light design.

Primer cratering is a common occurrence but is not necessarily indicative of high pressures. A cratered primer may be caused by an oversized firing pin hole in the bolt face or a combination of a generous firing pin hole and excessive firing pin protrusion (which is better than too little). I would advise that handloaders do not look at primer cratering as a pressure sign as there are other variables at play here.

A relatively harmless primer crater.

We can also use a micrometer to measure case head expansion at the shiny ring mark which develops on the case, just forwards

of the case rim. The shiny ring forms in the gap where the case is neither supported by the chamber of the rifle or the bolt and gradually expands with repeated reloading. Cases normally expand at this point to normal chamber dimensions (the dimensions just ahead of the gap). The trouble is, the chamber dimensions may be vastly different to that of new unfired brass and can differ from rifle to rifle. To this end, I am hesitant to offer acceptable diameter ranges and suggest pressures be read via primers, primer pockets and scuff marks.

Summary of Key Points:

- Learn each of the low and high pressure signs.
- Brass and primer brands also affect results.
- Changing bullet designs, especially without altering seating depths can cause pressure spikes- even though bullet weights are the same.
- Soft brass and primers can be used as an early warning system in older rifles.

13. Reset sizing die to correlate with head space

When you have finished your first range trip and fireforming session you will need to set your sizing dies to their correct and final settings.

If you are using a collet or bushing type neck sizing die (e.g. Lee, Redding), there will be no need to change settings. Simply stick with the manufacturer's set-up procedures.

If you are using a standard neck sizing die (e.g. Hornady), first remove the decapping assembly. Screw the die down until the locking ring contacts the press, then back the die out a full turn. Following this take a case, lubricate the inside and outside of the neck and proceed to neck size it. Note how much of the neck has been sized. If you cannot see this clearly use a good coating of Lee wax on the neck. This will give you a line which you can read. Once you have that proceed to turn the die down in quarter turn followed by eighth turn increments. Retest until the entire case neck has been sized without crushing the shoulder. Following this, set your locking ring in place; then set your decapping assembly in place, making sure the decapping pin only just passes through the shell holder. Your neck sizing die is now set up for continued resizing.

Be very wary of "shoulder bumping dies". In my own tests I have found that if ammunition is tight fitting, it is sometimes not the shoulder that needs to be pushed back. Instead the case body diameter just behind the shoulder is in need of reduction. The belts on belted magnums can also get blamed for tight fitting brass, when again the area just behind the case shoulder is to blame. A die that bumps back the shoulder can make this condition much worse. Remember, you are setting up your dies for your individual chamber.

To set up a full length sizing die, we can use a similar procedure to that just described. However, in this instance we will use the rifle as our guide, rather than reading a line on the case neck. Please note, if your bolt is very stiff to work you may wish to

disengage the mainspring of the bolt for this test. Mainspring disengagement and or removal is described in the rifle accurizing and maintenance book of this series.

With the full length die backed out one turn, size a case and test it in the rifle. If the bolt closes very easily, the head space may be very long and you may need to back the die out another full turn and start over with a fresh case. If the fit of the case is very tight, remove the case, turn the die down a quarter of a turn, resize the case and then check its fit in the rifle chamber once again. You may need to step back to 1/8th turns of the die as you get closer. Keep turning the die down until either:

- The case has a slight measure of feel when closing the bolt.

Or if using a lever action, gas, pump or dangerous game rifle:

- The case is sized just to the point that the bolt can be cycled with no resistance.

Once the correct die setting has been achieved re-fit the decapping assembly and then try sizing and chambering a case once again. With FL dies we need to check and make sure that the neck expander button does not stretch the case, making chambering difficult.

These steps will prevent incipient case head separation, while allowing you to reach a balance between function and potential accuracy. I cannot overstate the importance of correct die settings. Remember, the dies need to be set to suit your individual chamber. Your seating die will need no further

adjustments at this time. We can now move into more serious load development.

Summary of Key Points:

- Sizing dies need to be adjusted to final settings.
- No need to change settings on collet or bushing type neck sizing die (e.g. Lee, Redding).
- Other neck dies: Back off die one turn, then work down in incremental turns until neck is sized without impacting shoulder.
- Full length dies: Back off one turn, then work down in incremental steps until rifle bolt either closes with mild resistance or just closes easily, depending on rifle.

14. Incremental load development

Now we get to the knitty gritty, and we need to be right on our game when working up accurate loads. The following information is for those of you who wish to explore both, optimum accuracy combined with optimum velocity development. My definition of optimum velocity is a balance of maximum velocity within safe pressure margins.

If you are a beginner you may find that the information ahead gradually becomes too technical for you to take in at this stage.

In that case you may simply wish to perform basic incremental load development as per the paragraph ahead, using your reloading manufacturers booklet as a guide to maximum loads. Test fire your loads and select the most accurate load for your hunting / shooting situation. Shoot the rifle to a range that is within its accuracy limitations.

I strongly recommend that incremental load development be performed utilizing three shot groups, working up in half grain increments. We can change to .2 grain increments later, but for now half grain increments are all that we need. Ladder testing is a modern trend in which every shot is lifted by .1 grain across a total of perhaps twenty shots. The goal is to explore barrel harmonics and choose a load at a point where the bullets have printed closely together. While the principle of this method is sound, I find that this system can be quite messy. I have had many confused shooters contact me with their ladder tests, hoping I would be able to do a better job of interpreting their confusing results - generally I couldn't. Ladder testing tends to be popular amongst target shooters using heavy barreled low recoiling rifles and is not greatly suited to hunting weight high power rifles where human error is more likely to occur.

It is extremely important to understand that unless you are doing a heck of a lot of shooting on a week to week basis, ladder testing will produce false results due to human error. With this system it is possible to pull a shot either away from or towards the central cluster. The targets can also be very hard to read with so many shots on the one target. With three shot group testing the shooter must repeat the same shot three times. If two shots are very close together but one falls away, the shooter can stop and think about whether he may have pulled the shot or whether the load or rifle is at fault. If need

be, re-test the same load later on. If all three shots are close together, re-testing another three shots during a later shooting session will provide final confirmation for a total of six shots. I have seen a lot of BS in this game over the years, and as far as hunting rifles go ladder testing tends to be about midway on my BS scale.

When incremental testing I like to explore where maximum is for the individual rifle. This means that I may have to go above book maximum (please read safety warnings at the beginning of this book). My definition of maximum may differ from others, so I need to make this clear. My definition of maximum is a point where the brass or primer is beginning to show slight indications of strain but not to the point of being dangerous. This load will most likely cause excessive wear to the brass if used again. It may also prove extremely dangerous later on if the initial load work was performed in cool weather and was not tested in hot weather. So, once I have discovered this maximum without blowing the rifle to pieces, the charge will be noted in my journal as maximum. I will refrain from further loadings of this charge weight, generally working 1 to 1.5 grains or more below that maximum.

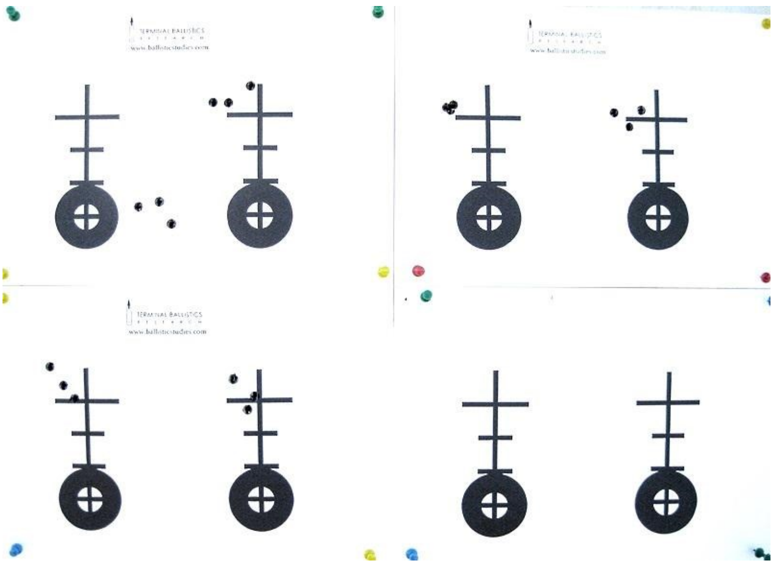
Reloading manuals are very cautious and with good reason - they have no control over chamber dimensions, particularly freebore lengths. A short or no throated rifle will generally reach maximum pressures with reloading manual loads. In this case we’re talking about the kind of maximum that creates enough pressure to rupture the case and push the rifle action to its design limits. Afterwards the bolt has to be opened with a mallet. So, we should be very grateful for the care put into reloading manuals - it could save your life one day.

As you gain experience with cartridges and throat lengths, you may reach a point at which you can predict where maximum may be. But as a measure of caution it is wise to start with a reloading manual, work up to book maximum and study fired cases and velocities. Then contemplate whether it may be safe to continue above book maximum during a further session. Load From A Disc is another means of obtaining preliminary predictive data. I also wish to reiterate the importance of writing on your brass (or a similar control system). You need to know which load was which, so that cases can be studied at home after each shooting session.

In some cases I can achieve excellent accuracy and velocities within book maximum. Other times I may have to go one or two grains over book maximum to achieve the velocities stated in the booklet along with optimum accuracy. In other cases I have had to go up to seven grains above book maximum in high capacity cartridges to achieve an optimum velocity / accuracy relationship, while still being a couple of grains below the maximum pressures that the brass will take. I very much hope that you understand just how dangerous it can be to make assumptions and simply load hot and fast. Do not do this without a thorough understanding of the individual rifle and the ability to read pressure signs.

A major goal of incremental load development is to explore barrel harmonics. To understand these you need to study targets. If you can imagine the barrel throwing the bullet as opposed to just firing the bullet, you will better understand just what is happening. To use the analogy of a baseball pitcher: In order to achieve a consistent point of impact the pitcher must let the ball go at the same point in time for each and every

pitch. Any discrepancies in arm movement or timing will affect results.



From top left: the first group is low. After shooting this group I made a rough adjustment to the scope, as I wanted the rifle to shoot a bit closer to its final setting (I wanted the rifle to shoot three inches high). The scope was not touched thereafter during load development. I could not fully predict the POI of the next group due to changes in barrel harmonics during load development. The second group shows two bullets close together with one flier. The POI shifted a great deal from initial scope correction due to barrel harmonics. The third group shows a harmonic sweet spot. The fourth group places one shot to the same POI as the previous group while its two mates take a walk. Bottom row: The barrel does not like either of these loads. The final target is clear - no shots fired. By minimizing or refraining from scope adjustments until after load development we can see changes in both group size and POI.

During ignition the explosion of burning powder creates a vibration along the bore. The bullet passing through the bore also creates vibrations and stresses. In contrast to this, the steel of the bore will have its likes and dislikes, its strengths and weaknesses relative to its temper. A primary goal when handloading is to find that sweet spot where the barrel vibrates in a consistent manner at the point in time when the bullet leaves the bore.

If we are shooting at extended ranges, we also need to find a load that produces a very low velocity deviation from shot to shot. The velocity deviation between the slowest and fastest shot in a group is called extreme spread or ES. If for example one shot yields 2800fps while the next shot yields 2900fps, the difference in the point of impact between the two loads may be up to or over a yard / meter at extended ranges.

And finally, another major goal of incremental load development can be the achievement of useful velocity. We can use velocity to extend the fast killing range of projectiles, we can use it to reduce wind drift, we can use it to extend the total effective range.

As luck would have it, many rifles display an ideal balance of excellent accuracy and a low ES when driven at very high velocities. However, accuracy sweet spots or harmonic nodes tend to come and go throughout the velocity spectrum. Very mild loads can display excellent accuracy simply because of a reduction in barrel vibrations. But at the same time, if the powder column is very shallow and poorly distributed, ES may be negatively affected because of an uneven burning pattern. I should also mention that there are times when very mild loads can produce dangerous pressures due to uneven burning. It’s

not just the hot loads that can cause problems. A good example of this can be found with Winchester 296 powder as used in the .357 and .44 magnum pistol cartridges. This powder can produce very high pressures with reduced loads, and it is much safer to load by following Winchester's recommendations which are in essence maximum loads. Another example is a short throated 7mm RUM I experimented with several years ago. Unfortunately at that time I did not have a full appreciation as to why Remington utilized so much freebore but I soon found out. When working up loads, starting with a mild charge, the powder burned unevenly. The RUM case is very large while the 7mm bore is very small in comparison. As unburned powder moved forwards into the throat the charge became less stable and pressures went through the roof. The only way this rifle would work was when loaded to near maximum pressures, the almost compressed charge igniting evenly and fiercely. Nevertheless, the ultimate solution was to lengthen the throat which I now fully understand to be a necessary gas expansion chamber for velocity generation while avoiding dangerous pressures.

To conclude this section I wish to reiterate that at this stage, we will be exploring loads that are within book maximum (or Load From A Disc). The first round of testing involves fireforming cases, this second session involves exploring accuracy and velocities within the guidelines provided by powder manufacturers. The third step will be to study brass and velocities and determine whether we can or need to explore loads above book maximum.

If you performed your fireforming with a mind to preliminary load testing, you will already have a basic idea of how the rifle and cartridge behaved and how it handled book maximum

pressures. You may now wish to move on to further tests at higher velocities if you have not yet found an accuracy / velocity sweet spot to re-explore and finalize. But remember, if going past book maximum, the brass is now a different shape and is a closer fit to the chamber. It will not have the same pressure absorption qualities so you need to back off loads a touch before starting over.

Summary of Key Points:

- First session - fireforming or preliminary / incremental load development.
- Second session - incremental load development to explore pressure, velocity, accuracy and ES within book maximum.

15. Load more ammunition

If you have discovered a potential sweet spot, you can now set about re-testing and confirming this load. This is discussed in greater detail ahead.

If you have not yet found maximum, you may want to continue increasing loads. When performing such tests I stay with half grain increments unless using a very small case (e.g. .223 Remington) and very fast burning powder. If testing a small high velocity cartridge with fast burning powder, I may use .2 grain increments from the outset. At the range I carefully extract each

fired shell, lifting the bolt slowly to test for any resistance. After the shell has been extracted, I carefully observe the case head and primer.

As I get closer to maximum for the individual rifle, along with case head and primer indicators, I might see groups open up all of a sudden. This can be another indication of high pressure, but not all of the time! Marks on the brass will often show a correlation to such groups. As soon as pressure signs are evident, it is time to stop. Any unfired loads will need to be dismantled with a kinetic bullet puller. This is an extremely handy tool for full load development.

Summary of Key Points:

- Session three - Finish any further pressure testing if necessary.

16. Explore sweet spots

By now you will have worked through the load spectrum and found “safe” maximum pressures. Hopefully, you will have found some sweet spots to work with and confirm.

While we are at it, let’s have a look at the total round count so far.

- We made up about 30 cases for fireforming and fired these off. Some of you used this as your preliminary load development phase.

- During session two, you fired around 24 rounds including foulers, steadily working up to book max. Some of you may have stopped here after finding an acceptably accurate load. If you had already performed preliminary testing, these 24 loads may take you through to maximum for your individual rifle while also establishing an excellent load that simply needs confirmation.
- If you did not find maximum, session three was used to finish pressure testing. This may involve up to 12 shots.
- Session four (or three if your pressure testing has been completed) will now involve testing final confirmation groups and working around sweet spots. Again we may fire up to about 12 shots.

Our total round count prior to sweet spot testing is around 54 to 62 rounds for basic load development which also allowed the handloader time to break in or simply get used to a new rifle. The beginner or those not interested in precision shooting will hopefully have noticed a trend in group sizes and be able to select an adequate hunting load, being mindful of fluke results. For example: If the average group sizes were around 2.5” in diameter and only one group was around the magic minute (1”), there is a chance that the one good load was a fluke. The rifle or handloads may need further work if the rifle is to be used for hunting beyond close to moderate ranges.

Those of us who are concerned with repeatability or precision shooting will want to see previous groups reconfirmed one more time at the rifle range and will want to explore sweet spots more closely and study ES. Total round count will end up around 62 to 74 rounds. The good news is, in all likelihood our

barrels are now thoroughly broken in and we are gaining a better understanding of the individual bore.

So, how do we go about fine tuning? Easy, we work around previous sweet spots in small increments.

For example, let's say that your .308 Winchester rifle produced an excellent group with 43 grains of *X* powder and *X* bullet. As a matter of both double checking and fine tuning, you can now set about retesting loads. With 43 grains as our potential sweet spot, we can test:

Fouling shots

42.8 grains x 3 shots.

43 grains x 3 shots.

43.2 grains x 3 shots.

I tend to find that .2 grain increments are ample for fine tuning and that .1 grain increments can fail to produce truly meaningful results. Nevertheless, if you wish to test finer increments, that's entirely up to you. It's your time and money.

As a final note with regards to round count, an expert handloader may utilize past knowledge and with an understanding of throat dimensions have the job done in two sessions with a very low round count. Fireforming loads are used to break in the already high grade barrel, a follow up of eighteen rounds completes the load development phase with a final three shots to confirm group sizes and velocities. But if the bore is anything less than settled, he cannot predict how this load will really perform until the bore is properly worn in with a higher round count.

Let’s have a quick look at such a job. Please be aware that the loads quoted here are way beyond powder manufacturer recommendations:

- Expert measures COAL’s of 7mm Remington Magnum chamber.
- Expert notes the rifle is in very good condition and is of sound (hefty) design.
- Twenty four cases set up with Trail Boss for initial fireforming. This will be enough for both load development and extra foulers.
- Following fireforming, loads are worked out for 160-162 grain bullet. Expert predicts that in this rifle, a start load of 71 grains H1000 (ADI 2217) will yield a mild 2950fps from his 26” barrel and that he should be at least 150fps below maximum velocity / pressure.
- Expert works up loads to 73.5 grains which he knows is near maximum. Velocity will be 3125fps or thereabouts - if he knows precisely what he is doing. Round count for session two is 20 rounds (18 incremental, 2 foulers).
- Session three for confirmation. May involve 3 to 9 rounds.

But if there is an anomaly in the barrel - an unknown tight spot or some other hidden factor or incorrect measurement taken - all bets are off in the predicted pressure department! The dangers should be obvious.

Once you have found a good load, make sure you actually record this as being a good load in your journal. This may sound obvious, but it is a mistake easily made. Your Journal may read something like this (hand written):

43.5gr: 2650, 2671, 2667, OK.

43.7 gr: 2661, 2668, 2672, Excellent (Three ticks).

44gr: 2771, 2668, 2684, Good.

You cannot measure groups when you are shooting unless you walk to the target and take group measurements between each group, then jot these in your journal. So, to play it safe I highly recommend some form of initial note taking such as the word "excellent" beside the best group and so forth. This way, if you are in a hurry to get home and accidentally mix up your targets or have any other unforeseen hiccup, you will at least have this basic reference in your notes. Once you have your targets in hand, you can also write down the actual group sizes beside each load. If a load is exceptional regarding both accuracy and ES, I put three ticks beside it as an immediate reminder that this load ticks all of the boxes for me.

As a final note in your journal you can state "My pet load is *XYZ*", so when you next open your journal there is a clear record of which load to use. Again, some of this may sound obvious; but sometimes, notes are missed and targets are lost. Please try to remember to take accuracy notes or ticks through each stage of the reloading and test shooting process.

Summary of Key Points:

- Test around sweet spots in .2 grain increments.
- Use session to confirm accuracy.
- Study ES (long range shooters).

- Make sure you record pet loads in your journal!

Temperature stability of loads

Occasionally, a rifle will give best accuracy at near maximum pressures. The trouble with such loads is that if these were developed and tested during the winter months or on a cold morning, they may prove dangerous at elevated temperatures.

The modern stick type powders produced by Hodgdon (ADI) are immensely stable across a wide range of temperatures. But if the rifle is already loaded to very high pressures, an increase in temperature may cause a dangerous non-linear pressure spike.

Put simply, if you have performed load development in very cold conditions, you may need to retest loads <u>incrementally</u> during warmer weather. Loss of accuracy is a further concern, doubling the need to test loads for temperature stability. If you are using spherical powder, take special precautions as pressure spikes can be severe.

During the Canadian winter temperatures can fall well below zero, yet keen rifleman continue to test loads. I am occasionally asked for advice regarding test procedures under these conditions (the reloader having already exceeded book maximum, the rifle showing very low pressure signs). But with such cold weather extremes it is hard to tell just how safe the load is. I often suggest placing a series of test loads against the

body, allowing them to warm up prior to test shooting. A hot water bottle filled with warm water is another option, the ammunition placed on the water bottle inside an insulated carry bag. In this manner, the shooter can perform incremental load development and test how the ammunition will perform during warmer conditions. We can also deliberately manipulate temperatures at the chamber of the rifle depending on how fast we shoot.

Later, the ammunition can be checked cold for accuracy and any loss of velocity relative to plotting the trajectory of the load. Canada is of course just one example; there are many areas of the world which display temperature extremes.

I would advise anyone planning a hunting trip (or shooting match) in very hot climates to develop some kind of system to mimic climatic conditions. The three areas of concern are safety, accuracy and smooth feeding (extraction).

I do not believe any more needs to be said on this subject other than to reiterate that ambient temperature must be taken into consideration during load development. This really is basic common sense. In my experience, Hodgdon (ADI) stick powder is very stable between the ranges 0 and 30 degrees C (32-86F), but as the temperature increases all bets are off if running high pressure loads.

Summary of Key Points:

- Ambient temperature can have a pronounced effect on pressures.

- Make sure cold weather loads are safe to use in hot weather.
- Warm or hot weather conditions can be mimicked with care.

17. Basic Troubleshooting

The most common problems I come across amongst beginners are die settings, generally a full length or neck sizing die set too low.

Dents in the case shoulder can be caused by:

- Die set too low plus too much case lube.
- Case lube on the case shoulder.
- Case lube escape port in the die is blocked.

Setting the die too low can also cause either immediate or gradual case head separation. Once the case is completely split the rim of the case will extract, often leaving the rest of the case body stuck firmly in the chamber! The rifle then needs to be taken to a gunsmith, or a “broken shell extractor” can be purchased from a gunsmithing retail supply store. This tool is not to be confused with a “stuck case remover”. The latter tool is used for removing cases stuck in full length sizing dies. A stuck case remover can certainly be a handy get me out of jail tool for novices, who after using insufficient lubricant have found their cases firmly welded to the inside of their dies.

Neck dies can also be set too low, ruining the shoulder angle and general case dimensions.

If your brass is dented the dents can be removed by fireforming.

Split case necks tend to be a sign of poor temper or faulty brass within a batch. This can on occasion also be caused by a rifle with an oversized chamber; however, this is not very common these days. It is something to be aware of, but should be seen as the least likely cause of split case necks. If the temper of the brass is poor the brass will need annealing. If the brass is faulty minute case splits may be apparent in new, unfired brass. Each time you handload take great care to inspect your brass for any problems, including case neck splitting or incipient case head separation.

The new unfired case on the left has a split neck and will need to be binned. It cannot be trimmed to the bottom of the split and the split will no doubt increase after firing. The case on the right has split due to work hardening. This case also needs to be binned while the rest of the batch needs annealing or replacing.

Ammunition which is difficult to chamber, no matter how far you set your die down, is normally created by an oversized expander button. The button stretches the case as you extract it from the die and makes the case too long to fit into the chamber of the rifle without force. To remedy this make sure the insides of the case necks are properly lubricated. If necessary polish the expander button on the decapping assembly.

Scales are another area that can catch out new players, producing inconsistent charges. Please refer to the scale section of this book for problem solving.

Cartridge overall length is another common problem. There may be problems obtaining correct readings when trying to establish the COAL. Some folk may try to seat close to the lands when the cartridge is not designed to be used this way, or vice versa. Again, readers are referred to the dedicated COAL section of this book. Have you got your COAL right? Are you sure? It pays to double check.

To be totally honest, if a beginner buys a solid Lee press, Lee components and a Lee collet die set, then reads and follows the instructions given by Lee, there is no reason why he should not be able to produce loads capable of reasonable accuracy. These dies are capable of producing much lower case and bullet run out than traditional generic two die sets (full length and seating). The differences are large, immediately noticeable and meaningful. And while I have talked about partial sizing with a full length sizing die and utilizing this or that trick to get the best out of a traditional generic two die set, you must understand that only so much can be gained. There may be times when you need to utilize a traditional die set, perhaps because you are

shooting a cartridge that is not well represented amongst current options. Nevertheless, as you get more and more into the accuracy game, you may need to upgrade to custom collet or bushing dies. Another option is to utilize a Hornady concentricity gauge and manually bump your ammo into concentric conformity (see concentricity gauges ahead).

Beyond these basic factors success comes down to rifle accuracy and shooter technique.

Summary of Key Points:

- Check die set up.
- Die brands and styles can cause problems.
- Check COAL's.
- Make sure scales are working properly.
- The answer is generally simple.

Troubleshooting the precision rifle

If you have not yet found an accurate load, you will need to carry on with further experimentation. But before we proceed with that we need to be sure that:

- The rifle is sound (see accurizing and maintenance book).
- The bedding is sound (again, see accurizing and maintenance book).

- Shooting technique is optimal.

Unfortunately some of you will be struggling with shooting technique. If you are second guessing yourself, the best short term solution is to have an experienced shooter test some of your loads. You could also borrow a rifle of proven accuracy which produces similar recoil to your rifle. This will help isolate human error.

We have not yet established whether the bore is at fault as described in the accurizing and maintenance book, and we still have a little way to go before we can draw such a conclusion. Nevertheless, if the rifle is shooting groups wider than 2” you may have to consider exploring the bore as a problem at this stage. It may be wise to refrain from any further experimentation until this has been addressed. Please use the Practical Guide To Bolt Action Rifle Accurizing and Maintenance book to explore procedures.

Concentricity

Up until this point I have avoided the subject of concentricity gauges. I did not add a gauge to our basic kit list because I do not wish to see those new to the game overwhelmed. Instead, I suggested that the beginner adopt a good set of reloading dies with the Lee neck collet dies being a good starting point among others. Some of you will however have started out with more generic standard type dies, either neck or full length sizers.

If you are looking for optimum rifle accuracy and have not achieved desirable results up to this point, now is the time to look at purchasing a concentricity gauge. If you want to get into the precision shooting game, a concentricity gauge is a solid

investment and to a great extent a necessity. It can be quite a shock to find just how far out of alignment our projectiles can be. Ammunition may look straight, but a gauge will soon show up hidden ails. For this book I deliberately tested non-concentric ammunition. I found that in a rifle capable of quarter minute accuracy bullet run out of up to 3 thou had only a very minor negative effect on accuracy, with groups remaining under a half inch. But with a run out of 6 to 7 thou, as often occurs with generic traditional full length sizing dies and traditional seating dies, the same rifle will group around 1.5 MOA. A huge difference!

You can find more information on concentricity gauges within the advanced operations section of this book.

Summary of Key Points:

- Concentricity is a number one issue when troubleshooting the precision rifle.
- Concentricitygauge an essential item.

Seating depth experimentation

If your rifle is shooting groups of less than 2”, the next step we will take involves seating depth experimentation. The figure of 2” that I have suggested as a cutoff point is based on past experience, with a bit of extra leeway. But in truth, I cannot fully predict a cutoff point. This is simply one method, one way to approach things in a step by step manner. To be honest, an inability to get below 1.5” at 100 yards with a wide range of test

loads immediately rings my warning bells. I have to consider potential problems within the bore, if all other factors (bedding, trigger, shooter) have been properly addressed. However, using the following methods we will give the bore a good chance to prove itself before we take more drastic measures.

More experienced handloaders will ask why I do not immediately suggest changing to another bullet. The truth is, in some cases the bullet initially selected was the best bullet for the particular hunting application. Another bullet may lack necessary or desired features. Basically, if a hunter (or target shooter) has his heart set on a particular bullet design, he will want to explore all options before parting ways with that bullet.

We can attempt to fine tune harmonics by manipulating seating depth. Let's say that you had your bullet set for a .2mm or 10 thou jump. We want to see something measurable as far as barrel harmonics go, so there is not much point in adjusting the jump by a very small fraction. By using larger increments we can explore barrel harmonics in a meaningful manner.

When you perform seating depth experiments, observe your targets and select the best group (even though all may look bad).

Work up a batch of around 12 loads. We will also increase powder charges ever so slightly to make up for lost pressure from the increased bullet jump. Alter the seating depths for each 3 shots in .5mm or 20 thou increments.

If your initial load had a jump of .2mm or 10 thou. The next test loads would be:

- Charge increase .2gr, .5mm / 20 thou jump x 3 shots.

- Charge increase .5gr, 1mm / 40 thou jump x 3 shots.
- Charge increase 1gr, 1.5mm or 60 thou jump x 3 shots.

You can even try a very long jump as a final test load. An example of this would be 3mm or 120 thou but with a charge increase of just 1 grain to play it safe. This will definitely affect barrel harmonics.

Total round count for this session will be up to 12 shots plus foulers.

Full round count so far is now up to or above 86 shots.

But what if I have a short magazine rifle and was not able to start close (.2mm / 10 thou) to the lands?

The .308 Winchester cartridge design as an example has a good deal of freebore. So, we cannot get very close to the rifling without running out of magazine space. Or worse still, we may lose concentricity (bullet sitting too far out of the case neck) unless we are using a bullet with a long body parallel. If we seat too long for the magazine, these loads may be ok for target rifles but not so good for hunting rifles. Instead, we will have to keep stepping back. And we can keep doing this, as long as we do not seat the bullet so deep that its ogive ends up in the case neck.

If any of your seating depth experiments showed promise, you can now re-commence working up test loads. If you believe you are near the sweet spot, work up loads in .2 grain increments. If you need to perform a wider range of tests, work up loads in half grain increments and fine tune or re-confirm later.

Full round count will now be between 100 and 120 rounds.

Finally, if you want to try loads touching the lands in a hunting rifle do so, but understand the consequences. My take on seating against the lands is this: Due to variations from bullet to bullet it can pay to have a measure of resistance against the bullet (slightly wedged). This is better than bullets just touching the lands with various resistance from bullet to bullet. If the rifle is to be used for hunting, we need to make sure we have our backsides covered in two ways. Firstly, we need to ensure good case neck tension; to this end the Lee crimp die can prove very useful. Secondly, the rifle needs a nicely polished throat, removing any sharp edges from chamber reaming that could grip the bullet.

Summary of Key Points:

- Use bullet seating depth as a means to experiment with barrel harmonics.
- Use large increments in jump to obtain meaningful results.

Projectile experimentation

If seating depth experiments have produced poor results it is time to move on to projectile experimentation. We will also talk about powder and brass experimentation later. But for now, projectile experimentation is in my experience the best next step in the sequence.

As I write these words, I also realize that our 120 round count sounds very high. If you read other publications, everything will have come together magically after just a handful of loads, and off we go bragging to our friends about what great riflemen we are. Nobody seems to want to talk about the processes of working through a difficult rifle. Yes, 120 rounds is a high round count for no result. If you own a 7mm RUM you should consider putting some play money away in your piggy bank each week from about now. Because by the time we are done with this next session and (if the barrel shoots well) you have had a day practicing with the rifle, the barrel will be a third done. That's the reality of it. Sometimes things just don't go like a nicely written story. When this happens, all you can do is pick yourself up and keep moving forwards until you reach a final conclusion. Unless you want to quit and commit funds to a new barrel. Either way, you have to follow this through if you are to achieve your desired goal. That's just the way life goes sometimes - reloading is no different.

Projectile experimentation is relatively straight forwards. The goal here is to pick a projectile that will hopefully complement the finicky bore. I generally recommend a very soft projectile that will swage easily to the bore, unless some silly super fast custom twist rate has been adopted. In that case, choose a long and tough jacketed bullet. Or failing this, pull the barrel and start over.

My general recommendation for a soft bullet is a straight Hornady Interlock, Sierra or Speer bullet. The Speer BTSP bullet is especially soft. If you are not hunting at long ranges, you may wish to experiment with a flat based bullet. This style of bullet may swage to a finicky bore of uneven internal dimensions in a

more complementary manner. Hornady, Sierra and Speer each make flat based bullets.

If you have already been using a soft bullet and twist rate is not a factor, all we can really do is to try and adopt something of a different brand and perhaps a slightly different shape. If for example you have been using the soft 162 grain 7mm A-Max for long range work, you may wish to try either the 160 grain Speer BTSP or the 168gr Berger VLD which although tougher has a different form to the A-Max.

We can also use bullet length as a means to alter results. A very long bullet can prove more stable when traversing the bore. That said, if we have already tried a long bullet, we may have to try something shorter.

At this stage, my concern is not just individual barrel harmonics but also potential flaws within the bore. The two flaws I am most concerned with (all other rifle factors having been addressed) are unseen imperfections within the bore and stress (poor heat treatment). But there is still a possibility that the bore will shoot very well with a complementary bullet. For example, a soft bullet or very long bullet may take bore imperfections in its stride. But if the bore is truly suffering a stress problem we may be pushing manure uphill, so to speak. It is your call, as to where you stop and decide to part ways with the rifle or re-barrel.

OK, so let’s have a look at the round count now. We were up to 120 rounds. The next phase with a new bullet will take us to roughly 144 rounds. If we find a load that works we will need to reconfirm and sight in. This will take us up to roughly 160 rounds.

Summary of Key Points:

- Try a soft bullet (thin jacket) versus a hard bullet (heavy jacket).
- Try a long bearing surface bullet bullet versus a short bearing surface bullet.
- Try flat base versus boat tail if not shooting to long ranges (definition of long range depending on cartridge and application).

Slow fouling bores

Copper fouling occurs as a bullet passes through the bore of the rifle. This can be both useful and a hindrance, depending on the individual bore.

At its most useful, the copper traces left in the bore create excellent bullet grip and prevent the bullet from slipping around. About the only analogy I can think of here is that of surfboard wax used for grip. Not that I know much about surfing - I much prefer hills to waves. In my experience few folk, including experts, truly understand how useful copper fouling can be. Instead they curse it and complain when it comes time to remove the often stubborn copper layering.

But for all of its usefulness copper fouling can also become problematic. Too much copper in the bore can almost act like a lubricant to the detriment of bullet stability and causing extremely wide fliers. More in depth research on this subject

can be found in my third book, the Practical Guide To Bolt Action Rifle Accurizing And Maintenance.

A slow fouling bore can be a tricky customer.

Occasionally a rifle will take between 8 and 10 shots to copper foul before it will shoot straight. In contrast to this, many rifles achieve a good level of copper fouling within 1-2 shots and reach their limit very quickly, losing accuracy after around 35 rounds. Some factory rifles will lose accuracy within 24 rounds when the barrel is still near new. In other cases, the factory bore may show good copper fouling after 1-2 shots, giving us the impression that all is well. But after heavy experimentation we find that the bore really needs a great deal of copper fouling to even out dimensional ills or flaws in the finish.

If the rifle is a slow fouler and our test loads totaled 24 rounds, the mild loads may, unbeknown to us, have all gone towards fouling and we may have missed a sweet spot down low. The question is, how or when do we decide to test for slow fouling. How do I as your guide set a rule for this?

One clue are fliers - two shots together with one flier. The rifle wants to shoot extremely well but keeps throwing the odd flier. This is quite typical of a slow fouler. Another clue may be a lapped bore. If we know the bore has been lapped to a high finish or we can see quite obviously that the rate of fouling is very slow, we may need to give the bore a chance to foul.

These are the two main clues that stand out. If either of these apply to your rifle I would suggest that after your initial incremental load work (.5 grains) and retest (.2 grains around potential sweet spot) you proceed to load up a batch of 12 to 15

rounds of the same load. The last 3 rounds will be your test loads.

Visual inspection of a slow fouling bore can be a bit tricky. Nevertheless, during cooling sessions between groups we can remove the bolt from the rifle, hold the rifle upright and check the muzzle for traces of copper fouling. If zero fouling is evident, you have a slow fouler. The key question is whether this slow fouling is relevant to rifle accuracy. Does the rifle need to be more copper fouled to shoot straight? Only testing will tell.

In other cases and as previously suggested a rifle bore can display a fine orange copper color and appear to be well fouled, but unbeknown to us it has not reached its optimum level of fouling. So, while there is copper fouling within the bore, by my definition I would call this a slow fouler.

If your rifle proves to be a slow fouler, you will need to adjust your cleaning regime accordingly. To prevent throat erosion, which can begin to occur within 250 rounds, I would suggest full copper removal after every 100 rounds (1 box of 100 projectiles or 2 boxes of 50 projectiles using a box count rather trying to remember an exact round count). If the throat is not kept polished, erosion at the throat (just forwards of the case mouth) can eventually become severe. This has a negative effect on accuracy and overall barrel life. This is another subject discussed in my third book. You'll also find fixes for this problem there.

When the rifle is in storage between full copper and carbon removal sessions, use a rust preventative coating within the bore that will not etch the precious copper. To re-foul the bore after a full copper removal session, use the cheapest bullet you can find or use Trail Boss loads as a means to introduce fresh brass to your batch. You can use your 8-12 fouling shots for

practicing offhand shooting. Or if accuracy is acceptable, you may be able to use your fouling shots for ordinary hunting out to moderate ranges.

Summary of Key Points:

- Slow fouling accuracy issue sometimes difficult to determine, slips by unnoticed.
- Make up 15 rounds of "the best so far" and fire all- slowly. Observe to see if or when group tightens.
- Adjust cleaning regime. Full copper strip out once every 100 shots etc.

Heavy copper fouling bores

Heavy fouling can be extremely counter-productive to rifle accuracy. Whether the bore is a slow or heavy fouler, it is important to get to know the bore of your rifle. During barrel cooling periods between groups remove the bolt and check the muzzle for copper fouling. If copper fouling is very heavy / bright, you may find a correlation between this and declining accuracy. Put simply, the copper will need to be removed with a dedicated copper solvent before commencing further testing. Fixes for heavy fouling rifles are provided in my third book which covers rifle accurizing and maintenance.

Summary of Key Points:

- Heavy copper fouling accuracy issue can normally be seen during visual inspections.
- Strip copper and work towards appropriate countermeasures.

Powder experimentation

If you have chosen an optimal powder for your cartridge I do not see a great need to experiment with powders. I often hear comments about a rifle that did not perform well, but after changing powders the rifle came right and shot straight. I have performed a great deal of these experiments myself. Looking back at all of this research and taking on board the accounts of other shooters, I believe that in many cases there is a lack of understanding amongst shooters as to why a change of powder helped. Had an optimum burn rate powder been chosen from the outset, such problems could have been avoided.

To me key factors in powder choice are, a powder that is temperature stable, relatively clean and of an optimum load density. A shallow case fill may cause uneven burning and poor uniformity from shot to shot. At the opposite end of the spectrum is a case filled to the brim with a powder that is too slow, where the primer may not be able to achieve a full and consistent ignition of the charge.

In other cases I believe that a change in powder simply alters barrel harmonics - essentially changing “when” the bullet leaves

the bore. This has nothing to do with a certain brand of powder producing mystical or magical results, while the former powder is now regarded as having the same qualities as dried horse manure mixed with a touch of nitrogen. There are many ways we can manipulate barrel harmonics and timing. Powder is just one option. Bullet jump, neck tension and incremental load development have equal stakes in this game.

Changing powder can however have an effect on ES if we need to reduce this. Also, some powders lack a good deal of temperature stability. In other cases the powder may prove difficult to ignite evenly without a good measure of neck tension and a hot primer. Winchester ball powders are good examples of this. They are often resistant to cooler primers and can also be quite temperature sensitive. Velocities may vary sometimes by as much as 100fps with changes in daily temperatures.

The main point I wish to drive home here is that powder experimentation is not the be all and end all, as some might have you believe after they lucked on to a good load, having used two or three different powders. If you chose an optimal powder to begin with and the rifle is failing to perform, do not expect miracles with the adoption of another powder. You can try another brand or a faster or slower burn rate, depending on the application. But be aware that to a great extent you are experimenting with barrel harmonics.

Summary of Key Points:

- Powder experimentation not necessarily what it's cracked up to be.
- Start with a temperature stable optimum burn rate powder to avoid having to experiment with other powders.
- Powder experimentation can be used to alter ES.
- Powder experimentation can be used to alter harmonics.
- Horse manure does not make good propellent powder.

Brass experimentation

Brass experimentation can be somewhat useful in that sometimes we can fail to identify flaws within a case. Misaligned case rims can go unnoticed, even after using a concentricity gauge. The same goes for any major issues caused by uneven thickness in the case body walls which cannot be rectified via neck turning. Major differences in case weight from a significant production problem may also go unnoticed. Differences in case temper due to production issues will most definitely go unnoticed. The seasoned target shooter will normally have a good handle on his brass before beginning load development. The hunter - not so. But even seasoned shooters can be caught out due to the subtle nature of some imperfections.

If you wish to, you can add 24 rounds to your round count plus foulers, adopting a new batch of brass, preferably of a differing brand.

To check for any case rim misalignment among your existing brass you may need to perform an eyeometer concentricity test by rolling cases across a sheet of glass or similar hard and flat surface. This is a very difficult test to perform, and it takes a bit of practice to see any misalignments at the case rim.

A case which displays uneven thickness from its rim to its neck cannot be fully rectified. However, the case thickness at the area of the neck can be made uniform and concentric via neck turning which is discussed in another chapter. For now I will say that I do not ordinarily neck turn hunting rifle ammunition - not even for precision long range work unless I have to or really want to for the sake of interest. However, if other experiments have failed you may need to check case neck thicknesses and pursue neck turning. The reality is that neck turning may only account for minor differences in accuracy unless the cases are seriously out of spec (3 thou or more variation). Another symptom of this includes high run out on fired cases (see concentricity gauges). To put things into perspective, if your current loads are producing accuracy of around 1.5 to 2” at 100 yards, and case thickness is showing 2 thou variation or less, neck turning won’t help a great deal.

Thick necks can cause problems by trapping projectiles, resulting in pressure spikes and destroying accuracy. To check whether this is affecting your rifle take a <u>fired</u> case and try to pass a projectile through the case mouth. The projectile should pass through relatively easily. If the case neck pinches the projectile, then either the chamber is suffering a carbon build

up (clean with an oversized bronze brush and solvent as per my third book) or the case necks are too thick. If the case necks are too thick, the brass either needs to be neck turned or discarded. It pays to perform the projectile pass through test every once in a while. Even high end brands can catch us out when least expected.

I do not generally weigh and sort cases into like-weight batches as some handloaders do. But on occasion a batch of brass may show significant variations in weight. This can affect case capacity which in turn will affect pressures - an essentially flawed batch of brass. This can also occur with newly developed cartridge designs. The trouble is, we may burn through a great deal of ammunition before we even begin to contemplate looking at brass weight. It can therefore pay to weigh brass as a first step during accuracy troubleshooting. When troubleshooting brass weight, I would suggest that for basic accuracy a variation of 3 grains is acceptable. If you weigh your brass, you may indeed find a few cases that fall outside of this weight range. These should be marked, set aside and perhaps used for such tasks as fouling shots or any other secondary purpose. We will spend some more time on this subject in the advanced reloading section ahead under the subject of brass preparation.

One last note regarding brass is that on occasion you may find new brass shooting better than fireforming brass. Without an understanding of what is going on this can be a little disconcerting. New brass can certainly be very compliant to a rifle chamber. Indeed, in some cases new loads will shoot extremely tight groups while fireformed cases show less than ideal results. All that I can suggest for this phenomenon, is that the handloader be vigilant of concentricity both before firing

ammunition and after. Check bullet run out before firing, check case run out after firing (see concentricity gauges). Problems may be caused by a mixture of dies producing very poor concentricity while at the same time, the brass is gradually work hardening- or the cases may have very uneven neck wall thickness (see neck turning).

Summary of Key Points:

- Check weigh brass and cull off extremes.
- Look for unnoticed flaws such as misaligned case rims.
- Study case neck concentricity.
- Flawed cases (batch) may need neck turning.
- Case temper may be an issue.
- If necessary and available, experiment with another brand of brass as another option.

Lee crimp die experimentation

The Lee crimp die provides us with a means to experiment towards greater accuracy and a lower ES. This die is not to be confused with traditional crimping dies. The Lee die could almost be called a neck collet die without a mandrel, but one that is used after the bullet is seated. By varying neck tension we can manipulate how the powder burns. That way we can alter timing and therefore harmonics. We can also create more uniform neck tension within a batch of cases where individual cases display varying levels of temper, depending on how many times the cases have been reloaded.

The Lee crimp die. Note the inner collet slots are open as I take this photo.

After crimping peak chamber pressures are reduced; the heavier the crimp, the lower the pressure and the lower the velocity. The pressure drop occurs because more energy is spent trying to release the bullet from the tight case grip. This can completely change accuracy sweet spots. Timing (when the bullet leaves the bore) can change quite dramatically. Velocity loss can be anywhere from 30 to 70fps.

So let's have a look at examples and play with ideas.

A rifle displays a sweet spot (best accuracy) at 3020fps without crimping, but the ES is very high (40fps). The powder charge is 72 grains.

For incremental retesting it is still best to start low because we do not fully understand the potential sweet spots with the

altered timing. Also, we need to be very safety conscious if working above high pressure sweet spots. Just because I have said that pressures are reduced, doesn't mean that we don't need to play it safe.

Foulers

71.7 x 3

72 x 3

72.2 x 3

72.5 x 3

72.7 x 3

73 x 3

Total 18 shots plus foulers.

Possible results:

- Sweet spot accuracy can occur above or below the velocities of the previous sweet spot load (prior to crimping). There is no way to predict which load will be most accurate.
- Previously tested load proves equally accurate after crimping but shows loss of velocity by *X*fps.
- Improvement in ES.
- ES does not improve because the barrel is a very heavy fouler (or some other bore or component problem).

To set up the Lee crimp die just follow Lee's advice: Back off the die locking ring, then wind the die down until it touches the raised shell holder. After this, lower the ram / shell holder and

turn the die in another half turn. You can then set the lock ring in place.

The only thing I wish to add to Lee's set-up procedure is that if you cannot see crimp marks at the case mouth, the tension is in all likelihood very light and may not produce meaningful results. You may need to turn the die in another quarter turn to achieve a noticeable change.

A standard handload on the left versus a handload crimped with the Lee crimp die on the right.

When crimping you can see the Lee collet open and close against the case mouth. Only a fraction of the case mouth is crimped. You can put an empty case into the crimp die to obtain a closer look at contact areas.

One word of caution: If too much crimp is applied the collet may become damaged. You can physically see the crimp collet close

during crimping. It cannot close any further than this and will merely become crushed if the die is set too low in the press.

Lee crimp dies cannot be used in a generic manner for crimping. In other words, you cannot use a 7mm-08 crimp die to crimp a 7mm Remington Magnum cartridge or vice versa. The crimp die is shaped internally (like the Lee collet neck die) to fully guide the cartridge and provide optimum concentricity as the cartridge is presented to the crimp. The Lee crimp die is only available in selected chamberings at this time of writing. Perhaps one day it will be available in a very wide array of cartridge designs.

I do tend to check for concentricity after crimping. So far, all has been well during my tests. The Lee crimp die certainly is interesting. The old phantom fiddler would love it.

Summary of Key Points:

- Use Lee collet crimp die to manipulate pressure, timing (harmonics) and ES.
- Crimp die drops peak chamber pressures at full crimp.
- Utilize wide test range- expect new sweet spots below or above previous. No fixed expectations.

Suppressors

Suppressors are well known for reducing recoil while also helping to dampen harmonics. But at times a suppressor (depending on the design, materials used and barrel contour) can add extra variables, including heat buildup and carbon caking. These issues are covered in my previous books. Personally I tend to perform load work without a suppressor. Once I have established loads, I will fit the suppressor and perform final studies and tweaks. Unfortunately there is a generation coming through in New Zealand and possibly the UK that simply cannot hold a rifle properly and is reliant on suppressors to act as training wheels. It is a double edged sword. My only advice here is to use your common sense. If you wish to perform load development with a suppressor fitted, be aware of the potential variables and consequences. Check for heat, check for carbon caking in the chamber by passing a bullet into the mouth of a fired case. If the fit is tight, chances are the chamber is caked. Yet another factor is that after a period of time the buildup of carbon inside the suppressor itself can change harmonics. This may affect loads in a negative manner and require fresh load development.

Summary of Key Points:

- If possible perform load work without a suppressor, then fit and perform final tests.
- Be wary of heat buildup.
- Be wary of carbon caking at the chamber.

Final thoughts on trouble shooting

One of the hard truths of this game is that more often than not, when a rifle produces very finicky performance (provided load development practices are sound), either the rifle or the shooter (technique) is to blame. With a sound bore, good bedding and a good trigger along with optimum technique very basic load development should allow us to achieve accuracy of less than an inch at 100 yards, and in many cases, less than half an inch. But sadly every once in a while, we simply cannot achieve these goals due to rifle limitations or as suggested, human error. If the rifle bore is a dud we can try to apply handloading troubleshooting techniques. If we are lucky we may find that the accumulative effect of addressing smaller variables can help us to shrink groups to acceptable accuracy levels.

If you are an inexperienced handloader (or shooter) it can be frustrating, trying to work out whether the rifle is at fault, whether it's your loads or your shooting technique. Sometimes it seems as though we must jump through a thousand handloading hoops, but this is not so. As long as we follow some basic rules and test procedures, while keeping a good written record, we can produce potentially accurate ammunition. If the rifle does not behave after following these strategies, it is time to look at both the rifle and shooter.

Before we leave the subject of troubleshooting I would like to talk about the phantom fiddler. This is the guy who reads a bunch of articles from various authors in gun magazines, then decides to pick one pet load from each author. This guy turns up at the range with perhaps four different brands of projectiles

loaded with three to four different types of powders. The only way he achieves an accurate load is by chance, and in some cases he will almost have burnt out the throat of his rifle during frenetic testing. If you come across this guy, stay the hell away from him. I have even seen gun magazine writers do it too - so be warned. The phantom fiddler lacks the patience to work through a project methodically. He simply cannot perform incremental load work because he wants everything now. His thought processes lack structure and he is not prepared to learn. The Eastern term for this is monkey mind. Be very wary of this personality type. If you are of this personality type, try to address your thought processes before addressing rifle issues.

Summary of Key Points:

- If the rifle and shooter are sound, basic handloading steps are all that is required to achieve accuracy.
- Utilize a calm, patient and methodical mindset when troubleshooting.

Extreme rifle accuracy

OK, let's be clear here - the less we have to do the better. Very few people want to be stuck at their reloading bench for countless hours.

We started this book with basic reloading principles and practices. We then moved on to problem solving. I believe that reloading for extreme accuracy is to a great extent a continuation of the problem solving practice.

Think about it, if you could just load up a very basic batch of ammo without special preparation and the rifle shot around .250” with an ES of around 10fps - why bother going any further. Well, sometimes this does happen. And so we see that in some ways reloading for extreme accuracy flows on from our basic load development. We do what we need to do.

Let’s say that you have a goal accuracy of under .5” at 100 yards with the hopes of getting down to .3” or less.

When reloading for extreme accuracy there are some steps we can take to help ensure optimum results. But again, I base these steps on the needs of the rifle.

The one thing that you must understand is that some of the steps discussed ahead will account for very minor increases in accuracy. When we put a whole bunch of these factors together we can shrink groups down that last little bit. If on the other hand your rifle is grouping around 1.5” / MOA and you are looking for tips to increase accuracy, do not be fooled into thinking that such practices as flash hole uniforming are going to save the day. If you are in this situation, about the only information of value to you in the section ahead is the subject of using a concentricity gauge. Apart from this you need to go back to the drawing board: looking at basic reloading practices and problem solving methods, re-exploring the rifle as a limitation, while also focusing heavily on shooting technique. With that said, we can now move on and look at finer tweaks and variables.

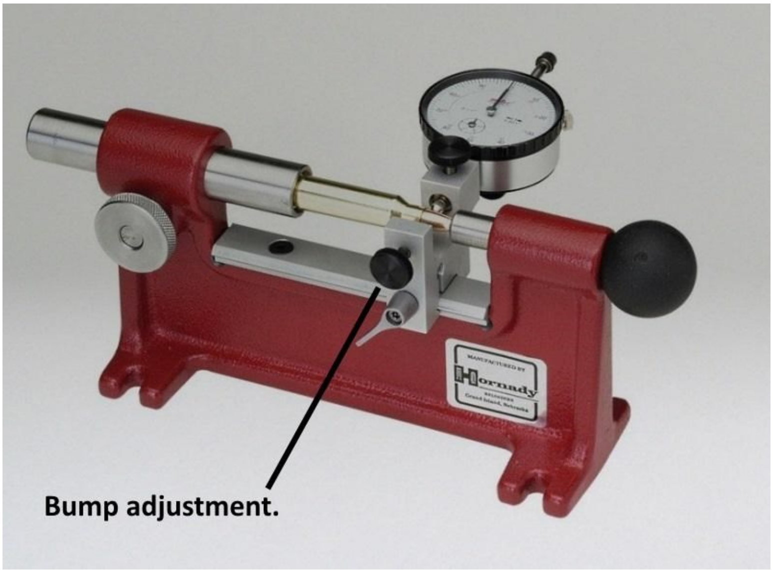
Concentricity gauges

I believe that this is our foremost tool in the extreme accuracy game. A concentricity gauge in very basic terms helps us to determine whether the projectile we wish to shoot is pointing square to the bore or whether the projectile wants to go walk about in another direction. We can use a concentricity gauge to study how our dies are affecting loads, whether the brass is true after sizing and whether the bullet is true after seating. As an added bonus, a concentricity gauge is a dead easy tool to use.

I currently use a Sinclair unit which works very well, producing meaningful results. There are other good designs on the market, including very basic and robust V block designs. They do not rely on ball bearings which may or may not be fully concentric in themselves. The Chinese DTI units (that would be the dial thingy on top of the concentricity gauge) typically sold with concentricity gauges are generally sound enough to help us improve accuracy a great deal. Those who wish to pursue the very limits of extreme accuracy may prefer to use a higher quality DTI of European, Japanese (Mitutoyo) or American manufacture.

The Hornady Concentricity Tool or “bump gauge” has pros and cons. The beauty of this gauge is that it can bump ammo. In other words, if we find a misaligned bullet, the gauge allows us to force the ammo back to true. Bumping or bending ammo is fine with me. The trouble is, this gauge holds the case at its rim. Having come across misaligned rims in a batch of Hornady brass (which must surely be a very rare thing), I believe we need to exercise caution if using this system. If in doubt roll cases on a sheet of glass / mirror or other hard surface and look for any

wobble in the rim. If all is well the Hornady gauge can be used without fuss. Burred rims are yet another problem which must be watched out for. Another problem with the Hornady gauge is that it cannot measure case neck run out. In other words, you cannot see where things went wrong. Did the shell come out of the rifle crooked? Did the sizing die set the neck crooked? Was it the seating die? None of these factors can be tested, only the concentricity of the final loaded cartridge. Nevertheless, the concentricity of the final loaded cartridge can also be corrected provided the case rims are true.



The Hornady Lock N Load Concentricity Tool.

For those who are into extreme accuracy I believe that having both, a Hornady Gauge and a Sinclair or V Block type gauge can be a very useful system. Ammo can be cross checked on both gauges, then bumped in the Hornady Gauge. Some may

wonder: Why the need to bump ammo? Shouldn't the ammo be made straight in the first place? Well, it's not a perfect world. There are many folk using a range of wildcat cartridges with dies that have to perform multiple tasks. It simply is what it is.

Summary of Key Points:

- A concentricity gauge is a key item- first purchase on your extreme accuracy tool list.
- Hornady tool useful due to ability to bump ammo but cannot help with troubleshooting.
- Hornady gauge requires concentric case rims in order to be accurate.
- High end gauges may prove more accurate than Hornady gauge.
- Two gauge system possibly useful for those who can afford it.

How to use a concentricity gauge

The following applies to ball bearing or V block style gauges, not the Hornady gauge. A simple way to use a concentricity gauge is to first measure fireformed cases at the neck. These should display great concentricity with a run out of less than 1 thou. If the cases already display a variation, the brass may well need neck turning or the chamber of the rifle may be misaligned. Both issues will need to be addressed in a step by step fashion, starting with a study of the case necks (see neck turning).

The second step is to observe neck or full length sized cases. Ideally we need to be under 3 thou for intermediate long range work. For precision long range work we need to try to get down to 1 thou or less. But this is a goal to work towards. It is not something that should cause you to go running into your bedroom, throw yourself on your bed, bury your head in your pillow, beating your fists and legs, while screaming like a teenage girl. It's just a goal to steadily strive towards. If you are over 3 thou run out, you will need to look into why your dies are causing problems. As a side note, if you are using the current Lee dies they should keep you under 3 thou, with around 2 thou being the norm but sometimes up to .025 thou. Care with technique can help minimize run out.

The third and final test can be made after bullet seating. The gauge should now be reset to measure projectile run out, not the case neck. By running the dial on the projectile, just behind the ogive on the bullet body parallel, we can see the final result and also determine whether our seating die is having a positive or negative effect on concentricity. Again, run out needs to be under 3 thou for a basic level of accuracy with the goal of 1 thou or less as the ideal. I am not a great fan of running the dial on the ogive of a bullet due to the forces involved in bullet forming / making. Some folk do measure their bullet at the ogive and indeed, in some cases we have little choice. But given the option, I prefer to measure just behind the intersection of the ogive and bullet body parallel.

I just want to be clear here. The very small difference from 3 to 1 thou may not be immediately noticeable at the range. Sometimes it is, other times the differences are so small as to be meaningless. The little things do however count at extreme ranges, such as using the .338's past 1200 yards. Here minute

differences in accuracy and any induced bullet yaw may result in wider groups, as well as a slightly reduced BC leading to a touch more drop or wind drift. That said, other factors can also come into play and effect BC, such as the bore. So, we must maintain a balanced perspective. Make your ammo, test it at the range, then test it at long ranges. Then decide for yourself what is and isn’t acceptable, based on how far you intend to shoot and what levels of accuracy are required to achieve this.

If you do not have optimum reloading dies and cannot access them for whatever reason, you can bump or bend ammo in a pinch. The Hornady gauge can be extremely useful for such operations; using it is much easier than performing this task by hand in a DIY sense. A block of tough wood or thick aluminum can be used to make a DIY bullet bumper. Simply drill a hole of the correct diameter into the block, then place the loaded round in the block so that the case neck takes the force. Following this, apply light pressure by hand in an upward or downward manner, depending on which way you are reading the gauge. This is a fairly simple process and after a short period of experimentation can help get us out of a bind. Some reloading dies are simply shocking, producing bullet run out of between 7 and 9 thou. A slight bend (while hopefully avoiding the upsetting of neck tension) can get us out of the creek or at least supply us with a paddle. As always, test shooting at a rifle range will verify both accuracy and ES.

Summary of Key Points:

- Measure cases after firing.
- Measure case neck run out after sizing.
- Measure projectile run out behind the ogive after seating.
- If necessary, bump ammo.

Brass preparation

Besides our normal approach as previously explained, I take a couple of extra steps to ensure the brass has a good start. To begin with, many folk avoid uniforming the primer pocket and flash hole during initial case preparation and instead focus on cleaning only which is quite fine. But for extreme accuracy I like to take the new batch of brass (or once fired) and uniform the primer pockets and flash holes. It really is quite surprising how many large burrs and flakes of brass hang about the inside of the primer pocket. If you take a new batch of brass and look into the flash holes you may be able to see what I mean. A good flash hole uniformer will create a hefty chamfer on the inside of the flash hole, really helping the flame to fan out evenly.

This 7mm Ultra Magnum case has been necked up to .338 caliber in preparation to be used in a .338 Edge rifle. In this photo, the primer pocket and flash hole have been uniformed.

Following this the cases are neck sized, trimmed and chamfered. I take great care to get the chamfer correct: more on the inside of the case mouth, less on the outside. This is followed by a dull off with a poly pad. After that, I am ready for fireforming.

I do not batch weigh my brass if I can avoid it, but sometimes this simply has to be addressed to lower ES. I think the key here is cost. How much brass can you afford to lose? This being the major factor, it is up to you to define an acceptable weight range.

Let’s have a look at an example. I have a batch of fifty Federal brand 7mm Remington Magnum cases. I weigh each and place them down in rows from lightest to heaviest (no primers):

One weighs 231 grains.

Eight weigh around 232 grains and up to 232.9 grains.

Fourteen weigh 233 to 233.9 grains.

Twenty weigh 234 to 234.5 grains.

Six weigh 234.6 to 235 grains.

And funnily enough, one provides the opposite extreme, weighing just over 235 grains.

Looking at the weights, we can see from the bulk, that Federal were aiming for a target weight somewhere between 233 and 234.5 grains. The question is: What are your cull limits? Personally, I will cull the two extremes and no more, provided accuracy and ES is sound. If I find problems I may have to cull down to the fourteen and twenty. What would you do? Cull the extremes? Cull to the fourteen and twenty? Or cull to the twenty and buy more brass immediately. It’s your call; rifle accuracy or more generally ES being factors that may influence your decision.

Again, I look at this from a problem solving perspective. Many of my clients simply cannot afford to fork out for several packs of brass in order to source a batch of like weight cases weighing within a grain of each other. On the other hand, some folk want to shoot to a mile. And this cannot be achieved with any great degree of accuracy, if we have an ES of say 20fps. The vertical dispersion at a mile would be huge, regardless of which cartridge or bullet we use. In such cases, we need to do our darndest to get down under 10fps if at all possible. What you do is entirely your business, all I want to address here is how we approach things.

One thing to keep in mind is that a variations of three grains in case weight is not the same as a powder charge variation of three grains. The percentages and ratios are much different.

I do not neck turn brass unless I have to. Neck turning is discussed in more detail ahead.

Summary of Key Points:

- Uniform the flash hole.
- Extra care with case mouth deburring.
- Weigh, study and decide on acceptable weight range.

Projectile preparation

About the only time you want to weigh bullets is when checking scales with a good quality match bullet. This will give an indication of the general range of the scale, so that you are on the same page as powder manufacturers and peers. Outside of this it can be a bit frightening to discover that projectiles do vary somewhat from bullet to bullet. But the truth is, as a percentage relative to the weight of each bullet, these differences are insignificant. In other words, there is no need to batch sort bullets based on weights.

Meplat (bullet tip) uniforming of match hollow point bullets may come into effect at very long ranges though this subject is still very debatable. My own tests and those of others have

shown that the very tip of the bullet can be somewhat irregular and still shoot well, while the heel of the bullet is very sensitive to irregularities. Nevertheless, meplat trimming (increasing frontal area and exposing a hollow point) can prove especially useful when utilizing match style bullets for long range hunting.

Bullet deformation is another issue where we need to be careful with assumptions. A dented soft point can simply be reshaped, and though its form will differ from its siblings it will still shoot well. Even out to reasonable ranges, provided the tip is reasonably concentric. Such are the peculiarities of ballistics. But a damaged bullet heel can be quite different. Every once in a while you may come across a bullet with a marred or burred heel. In all of my years of reloading, I came across my first marred A-Max heel only a few days ago. That bullet will become a fouler - no worries. More commonly, we can damage bullet heels during bullet seating if the case mouth is very sharp. The effects may be small but still evident.

Summary of Key Points:

- Try to avoid weighing bullets - a frustrating affair.
- Meplat trimming and uniforming not critical but can be useful for long range hunting rifles if meplat can be made wide.
- Heel of bullet critical (care of heel).

Neck turning

As we get further down the rabbit hole we find ourselves confronted with neck turning. In target shooting rifles the chamber is sometimes reamed with a tight neck reamer. This allows the case to open up only a small amount as it releases the bullet during ignition. This enables the case neck to fully guide the bullet without excessive play during or after case neck expansion. In custom built target rifles the neck area of the chamber may be so tight that neck turning is a necessity. The operation of neck turning allows the handloader to obtain a concentric case neck, while also providing a means to control the level of play in the tight neck chamber.

The K&M neck turner and pilot (lock stud) for use in a drill. A green or maroon poly pad (Scotchbrite / Norton Bear Tex) can be used for final polishing. The lock stud utilizes Lee priming

shell holders. I suggest hand turning rather than the immediate use of a drill until one gains a feel for the process. If using a drill, always use low speeds to prevent binding.

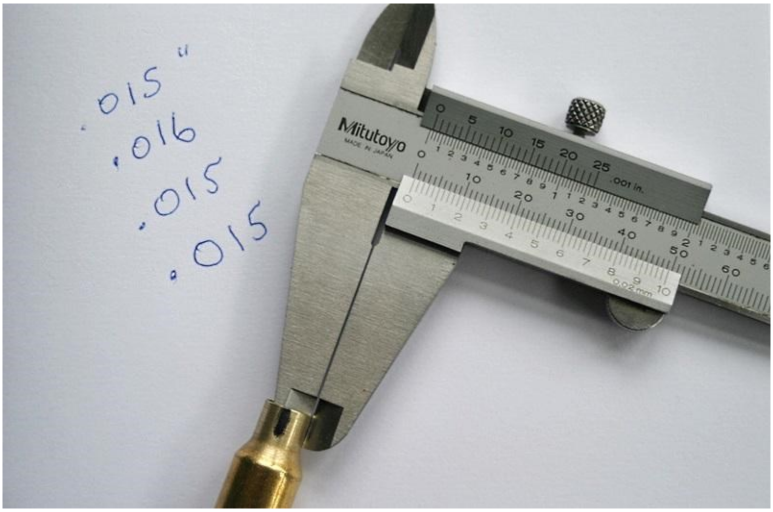
In sporting rifles, including long range hunting rifles, as well as sniper rifles it is customary to use a chamber reamer with a standard neck diameter. This practice normally also applies to wild cats and custom rifles, unless a tight neck is specified in the design which for the most part is rare. When neck turning for these rifles the goal is to only remove just enough material to true the neck, without opening up the distance the case neck has to expand during ignition to any great degree. We remove only what we have to. The same rule applies to target rifles, however more material may have to be removed to achieve safe tolerances and mild pressures.

Outside of the necessity to neck turn for tight neck chambers we have two options. Either set about measuring case necks and commence neck turning from the get go, prior to any fireforming or other reloading operations. Or test fire ammunition and decide whether we may need to neck turn. This decision can be based on accuracy or on case neck concentricity (as observed after firing cartridges and then checking the cases on a concentricity gauge).

Every once in a while I will come across a batch of brass which comes out of the rifle with between 2-3 thou run out. The rifles have concentric chambers which leaves only the brass (uneven case wall thickness) as a variable. In this sense you can sometimes pick up on problems by measuring case neck concentricity immediately after firing.

To properly measure case neck uniformity we can either use our vernier calipers or a ball micrometer. A good quality ball

micrometer tends to be a more accurate measuring tool for this operation, however many handloaders use a vernier caliper. A case can be marked at 12, 3, 6 and 9 O'clock with a marker pen on the outside, then gauged at each pen mark to study neck wall thickness. In most cases some degree of variation will be apparent. The goal of neck turning is to reduce this to a variation of less than 1 thou (.001").



Checking the necked up 7mm RUM brass prior to .338 Edge fireforming.

Micrometers are very sensitive tools, and it can take a good deal of time to get the right feel for when to stop as you wind the micrometer dial in. A soft hand is the key - very light fingers, stopping the moment any resistance is felt. If the mike is simply wound in hard it can crush material with relative ease, and no doubt this can also be very hard on the tool. It can take a great deal of practice to use and achieve consistent results with a

micrometer. RCBS make a relatively inexpensive ball micrometer while K&M produce a modified Mitutoyo unit of premium quality.

To neck turn, cases must first be sized as per normal, then run through a neck expanding mandrel. The mandrel opens up the case neck to an optimum diameter for the case neck turner. It pays to buy your mandrels from the same manufacturer as your neck turning tool. I currently use a K&M neck turning tool along with K&M mandrels.

Running my 7mm RUM brass (soon to be .338 Edge) through a K&M mandrel. Make sure you use plenty of lube when performing such operations.

Using the mandrel is much the same as using a basic full length sizing die, in that the insides of the case necks need to be

lubricated before running the mandrel through. Once the mandrel has been passed through the cases, they will need to be tested to see if they fit onto the pilot of the neck turn tool. Make sure the pilot is lubed to prevent cases becoming stuck. If cases display a degree of spring back after the mandrel has passed through and the fit of each case is too tight on the neck turn pilot, the process will simply be unworkable and the pilot will need very slight sanding. This can be achieved by mounting the pilot in a cordless drill and spinning it, holding fine sandpaper (320-400 grit) against the pilot. Normally only the lightest touch is required, so be very careful. Any extra play as a result of over sanding will lessen the accuracy of neck turning.

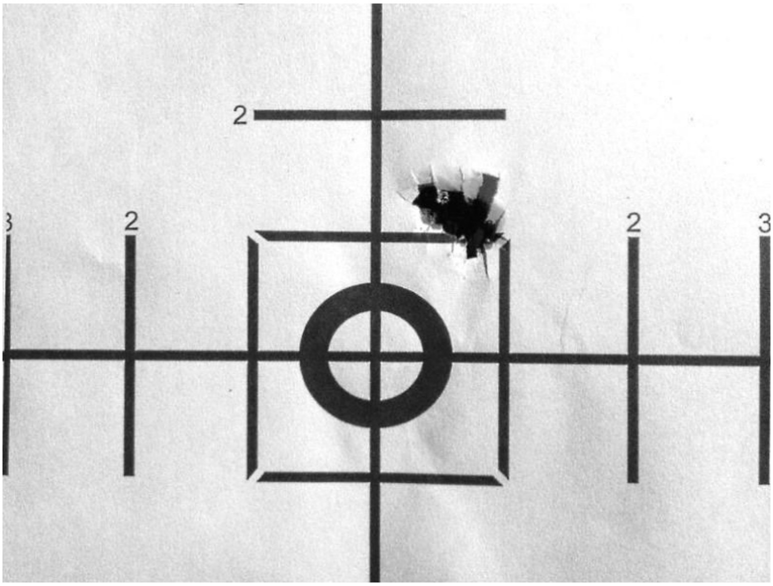
Once the fit is such that cases pass onto the lubed pilot in a smooth manner and without play we can commence setting up the neck turner for cutting. Each manufacturer provides specific set-up instructions which need to be read carefully and followed to the letter. Beyond this the process requires a degree of experimentation, and you may kill a few cases before getting a handle on it. It pays to remove only small amounts of material with each pass, and for this reason some folk prefer to have two neck turning tools set up for permanent use with a given cartridge. One neck turning tool being used for a first cut, the second used to make the final cut. You may simply wish to run your batch of cases through a neck turn tool with a light cut, then reset the tool for a second cut. Or you may simply opt for a light skim, all depending on the level of uniformity required versus how poor the individual case necks are.

Saying goodbye to that 1 thou (.001”) that we saw in my note.

When neck turning for long range hunting rifles, few people neck turn to the point where the entire case neck has been cut. The more common skim approach will generally cut high spots and not touch low spots, leaving the case looking rather marred and unhappy. But a quick outside chamfer at the case mouth and a poly pad finish on the case neck soon has all of our little soldiers looking neat.

Neck turning can be performed by hand or with a cordless drill. If using a cordless drill, feed the case into the tool at a slow and steady rate and try to keep RPM low. You will need to cut right to the intersection for the shoulder but not into the shoulder, potentially weakening the case. By the same token aggressive case neck turning can also weaken the case neck and lower case neck tension.

It takes time to set up a neck turner, so be patient with yourself as you work out how to use the tool and the optimum cutting depth when uniforming your brass. Be prepared to throw away a few cases as you learn.



A group shot with the .338 Edge rifle handloaded with the 285 grain A-MAX. This rifle groups between .260" and .335" with 90 grains H1000. Velocities are not as high as I would like at 2666fps, however the barrel on this rifle is relatively short. The ES is acceptable at 14fps but certainly not below the 10fps mark. Many ill-informed folk would look at this group and the Edge cartridge and expect it to perform well at one mile (1760 yards). Just like old such and such said you can do with a .338 Lapua or Edge. But the reality is, without further load experimentation (or perhaps a longer barrel) the rifle cannot be expected to perform much past 1225 yards. Nevertheless, this rifle certainly suits my needs and I am extremely happy with the results so far.

Summary of Key Points:

- Neck turning is essential for custom tight neck target rifle chambers.
- Neck turning optional for other rifles.
- Base decisions on rifle accuracy.
- Measure necks with a vernier or ball micrometer.
- Expand cases on a mandrel.
- Neck turn - Read and follow manufacturer's instructions carefully.

Neck tension

In my experience, neck tension can be a key factor in minimizing extreme velocity spread (ES). It is important to keep ES low when shooting at long ranges because a high ES will cause a great deal of deviation in elevation from shot to shot. Depending on the cartridge power, the BC of the bullet and ranges, this deviation may equate to over one yard / meter of elevation error. To this end, a group that produces outstanding accuracy at 100 yards, may prove hopeless at long ranges if we cannot reduce ES.

By increasing neck tension, we can often gain more uniform pressure and therefore velocity. This can however be somewhat of a double edged sword because increasing neck tension can lead to greater case distortion which in turn can ruin

concentricity. On the flip side, a tight necked case will generally hold better concentricity during action cycling - if the rifle is not a smooth feeder and is prone to 'bump' projectiles out of alignment within the case neck.

There are a few ways we can approach neck tension experiments. To begin with, if you are using Hornady dies, you may wish to swap the expander button (or entire spindle assembly) for a button of a smaller diameter. The plus side of this is that the smaller expander button will prevent a great deal of distortion and lost concentricity that can occur when using Hornady expander buttons. You can use a concentricity gauge to monitor concentricity during these experiments.

If you are using a Redding bushing die, case neck diameters can be taken down in two steps, using two separate bushings. If only a single (large) step down is taken, there is a risk of distorting the case neck slightly which may interfere with concentricity.

A third method is to use a crimp die, whether that be a dedicated die such as the Lee crimp die mentioned within this book - or the crimping feature within a traditional die set.

There is little more that can be said on this subject. Basic experimentation and monitoring of concentricity are what counts here. There is no point looking to this or that expert for the right answer when it comes to neck tension as your rifle will have its own preferences. Many authorities suggest that handloaders utilize very light neck tension to minimize case neck distortion during sizing operations as a means to maintain optimum concentricity. This is certainly valid and not to be ignored. Nevertheless, please understand that other variables do come into play.

Dies for an accurate rifle. In this instance, the rifle prefers very tight neck tension which enables the rifle to produce extreme accuracy while maintaining a very low ES. But to do this, the neck diameter of cases must be reduced in two steps. The first bushing is .332" (Redding's recommended minimum for the .300 Weatherby Magnum). The second bushing is .327". Note also the two locking rings shown on the right side die for comparison. The lower black locking ring is the original Redding locking ring and is too small for optimum use in a Forster press. Therefore, both dies are fitted with Forster locking rings.

Summary of Key Points:

- Use increased neck tension to experiment with ES.

- Watch out for any loss in concentricity.
- Accuracy may increase in rifles which do not feed smoothly and are prone to bump loads out of concentric alignment.

Final thoughts on handloading for extreme accuracy

Yesterday, I took four of my rifles to the range. I wanted to check that each was shooting well with previously established loads. The rifles each shot under .3” at 100 yards, or in artillery speak inside .3 MOA. None utilized neck turned cases or batch weighed brass. Everything went very well. These rifles shot well because they were put together right, the handloads were concentric and I did my part at the range. But as for advanced mystical processes and measuring steps - not really. I just followed the basic rules that I have outlined in this book, nothing more. Neck turning is an option for the four rifles but it is certainly not a necessity at this stage. Ultimately, results speak for themselves. We do what works. Had one of the rifles not shot well, then I would need to go back through each of the steps outlined in this book.

When it all comes together. This prime New Zealand boar was taken with a 7mm Remington Magnum. There was little room for error and little time to take the shot. The animal appeared just on dark, on a steep ridge over 600 yards away as the rain began to pour. One shot with a carefully developed hand load did the job.

No data for my cartridge or bullet weight?

Once in a while we find ourselves in a situation where load data is hard to come by. A new custom bullet design of a unique weight is a good example of this.

Basic common sense is all that is required here. Using a medium to slow burning stick type powder, a general rule of thumb is to add or remove 1 grain of powder for every 10 grains of bullet weight added or removed.

As an example, let’s say we want to use the 165 grain Matrix bullet in a .270 WSM. The Hodgdon and ADI load manuals show a start load of 63 grains H1000 (ADI 2217) powder with a 160 grain bullet. No load data is provided for a 165 grain bullet. Using our 1 grain of powder per 10 grains bullet weight formula, we need to remove a half grain of powder, making our start load 62.5 grains.

Delving further into this example, we used a slow burning temperature stable powder that was not prone to sudden pressure spikes. I can also state from experience that the Matrix bullets are a good example of a bullet design that will sometimes reach full velocities and pressures with less powder than would normally be used with more common bullet designs. To this end it would have been unwise to use book maximum load data as the basis for our formula. Remember, a change in bullet design, not just the weight, can have a profound effect on pressures.

Wildcats are another example of a situation where we may find ourselves confronted with a lack of load data. As an example, my 7mm Practical wildcat cartridge is based on the 300 Winchester Magnum case necked down to 7mm. By using a slow burning temperature stable powder (H1000 / ADI 2217), I was able to build initial loads with a good deal of confidence. My 7mm Practical is based on a case which is slightly larger than the 7mm Remington Magnum case. This meant that I could start with 7mm Remington Magnum maximum loads with my slow burning powder and be assured that the loads would be safe. Another method would be take a case and fill it to the bottom of the case neck with slow burning powder, then weigh the charge and remove 20% and begin start loads there.

Nevertheless, reducing charges by 20% can be dangerous when handloading overbore cartridge designs.

In laymans terms, an overbore cartridge is simply a cartridge of very large powder capacity versus a very small bore. In other words, a lot of energy must be passed through a very small orifice with obvious pressure risks. If you turn on a kitchen tap, the water flows into the sink nicely. Put your finger over the tap and block off half the outlet and the pressure rises. Necking large capacity cases down to small bores can produce dangerous pressures if <u>too little</u> or <u>too much</u> powder is used. Too little powder can cause detonation issues involving a terrible condition in which the powder charge burns unevenly, resulting in unexpected and often dangerously high pressures. Too much powder can also cause dangerous pressures so we can be left with a very narrow window. The shorter the throat, the lower the capacity for gas expansion. This is why the RUM cartridges are designed with nearly a half inch of free bore. Occasionally an immensely overbore wildcat may be designed by a user in such a way that it lacks any measure of free bore for gas expansion. Correct choice of powder burn rates in high capacity wildcats is obviously critical.

Without any form of assistance, powder charge rate estimation can really only be based on either past experience with cartridges of a similar case capacity and free bore or from studying load manuals (again regarding similar cartridge designs) - exercising the utmost care towards safety. Better still is to use a program like load from a disc which can make accurate predictions based on carefully measured inputs. This program is far superior to my 20% reduction which as suggested, could indeed prove dangerous when used in some

overbore wildcats. Load from a disc is ideal for wildcat development of any nature.

Ackley Improved wildcats can be dealt with in a more straight forward manner. We can look for data on the parent cartridge in our reloading manuals, then perform incremental load development in various stages, exploring pressures as outlined in this book. It is surprising the amount of emails I receive from shooters who want me to supply a load for their Ackley Improved as if I am somehow able to magically test the individual chamber dimensions of their rifles and guess the brand of brass used. If you want to go the route of Ackley Improved cartridges or wildcats, you need to perform your own load development and use a chronograph to obtain and record velocities.

So what happens if we create a wildcat based on necking a cartridge up to a wider bullet diameter, such as necking up the .300 WSM to .358 caliber. The medium capacity medium bore cartridges driving heavy bullets often do the best work with slow, but not super slow burning powders. We can also assume that because we are necking the case up to .358 and not down, pressures will be reduced, not increased. The Hodgdon / ADI manuals show a start load of 54 grains H4350 / ADI 2209 with 220 grain bullets in the .300 WSM. From this we can assume that the same charge can be used safely as a start load for the similar weight 225 grain .358 bullets without pressure concerns. If we extend this a bit further again and neck the .300 WSM case to .458, things get a little bit more complicated, a short case neck and minimal shoulder for head spacing being immediate problems. But let us assume that we have designed a reamer and modified case design to overcome these problems and are now faced with load development. The big bores

generally prefer a relatively fast burning powder due to the case to bore ratio. Fast burning powders can be tricky customers (pressure) but on the other hand, we are not trying to squeeze a large volume of powder through a small orifice (called overbore). We actually need a fast burning powder as we do not have a small orifice generating pressure. We make a start by necking up our .300 WSM cases to .458, fill the case with a relatively fast burning powder like H4895 / ADI 2206H powder to the bottom of the neck, then remove 20% and set this as the start load. We will most likely be under loaded but the loads will be safe. To further help safety, we can utilize a light for caliber 300 grain bullet. After our initial load work we can then use our 1 grain per 10 grains bullet weight formula to predict start loads for other bullet weights.

If you do not wish to use a program like load from a disc, you must develop an understanding of various cartridge designs and optimum powder burn rates before embarking on any wildcat journeys. By studying case capacities and reloading manuals you will gradually build a picture of how things work before your adventures. Careful study, combined with common sense are essential. There is no room here for simply “trying a load”.

Summary of Key Points:

- Where no data exists for a given bullet weight, interpolate book data using the 1 grain powder per 10 grains bullet weight rule.
- Where no data exists for a cartridge, study cartridges of similar capacity - but take free

bore into account (compare maximum COAL’s).

- Load from a disc can prove the safest option when building wildcat loads.
- Be very careful regarding both under loading and overloading wildcats.

Annealing brass

New brass cases are very malleable but at the same time contain a degree of spring tension. After repeated firings the brass can become work hardened and brittle at the neck. Once this occurs the work hardened cases can display increased neck tension and poor bullet release, leading to accuracy problems. As the cases become even harder, the neck and shoulder area of the cases begin to show small splits. This is not to be confused with the splits that can occur within a new batch of brass as a result of forming flaws. That said, in some cases work hardening and splitting can occur within four firings if the batch of brass is of very poor temper. This is not however all that common.

If you are a beginner, there is no need to read this section beyond this paragraph. My advice to beginners is that after a period of time, when the brass has been used many times and feels more difficult to work in your press, the primer pockets are gradually opening up or accuracy is generally diminishing, simply replace your brass - job done. If you notice split case necks, the brass needs replacing. If you are running a mild .308 Winchester and neck sizing without greatly working the case in

your press, you may get up to a dozen firings before you have to bin your brass. If you are running a hot loaded magnum, you may have to bin your brass within perhaps a half dozen firings. If accuracy remains fine, you may simply be able to keep using your brass up until the case necks begin to split after becoming much too hard. Split necks determine when you absolutely have to junk brass. A loss of accuracy can signal the need to change brass but other factors may also be involved, such as throat wear and a need to re-work loads. Replacing brass is much simpler than annealing.

Cartridge case annealing is all about regaining malleability. The brass needs to be annealed at the neck and it is also acceptable to have the heat pass down into the shoulder. It is extremely important that from the case head (rim) to about the midpoint of the case body the case remains relatively hard and tough. If this area is made soft through annealing there is a risk of the case head splitting. Yes, I know it seems like quite a contradiction - anneal the necks to prevent splitting but don't anneal the case heads or they will split! However, we have to remember that the case head is a good deal thicker than the shoulder and neck area. Two different animals.

The trouble with annealing is that it can be very difficult to achieve the same temper with each and every cartridge case. This in turn affects neck tension and can result in poor accuracy or a poor ES. Cases can also be made far too soft. Nothing will ruin your day like seating a bullet, only to have the case fold up like tin foil.

The old methods for annealing were less than ideal. The brass was set in a pan of water as a heat sink for the case head to prevent any annealing in this area. The top of the case was then

heated with a blowtorch to a dull cherry red (observed in a semi dark room) before tipping the brass over into the water, rapidly cooling the neck. There are still parts to this story that I do not understand myself. For example, to anneal any alloy the part is brought up to a temperature in which the grain structure changes, after which the part is left to cool very slowly. Tipping the brass over into the pan of water to cool the necks is more in line with heat treatment. As a second factor, the cherry red color on brass is an indication that the brass has become very soft. If left to cool naturally (anneal) the shoulders of cases heated to a cherry red often collapse during bullet seating operations. So, I believe our predecessors heat treated their brass. I have used this process myself and it has worked OK and helped halt case splitting. But I have never used this method successfully as far as extreme accuracy goes.

One modern approach to annealing is to utilize a heat sink (whether water or heavy aluminum) and use a temperature reactive crayon. Heat the case neck to the optimum 750-800 degrees Farenheit (399-427 degrees Celsius) and within a few seconds of being held to this temperature pull the flame away from the brass, allowing it to cool naturally. This process is still not exact as far as 100% uniform case neck tension goes.

Tempilstik produce heat indicating crayons which come in a wide range of temperature settings. The 750 F / 399 C stick is the most useful for brass annealing. Nevertheless, this method is still fraught with problems. The crayon is a dry type, much like cork. The crayon cannot be applied to the case before annealing as it simply does not run like a crayon. Instead, the brass must be heated and the Tempilstik periodically rubbed against the case. Once the case hits optimum temperature, the Tempilstik finally melts and leaves a smear on the case (or whatever metal

part is being worked). At this point, the flame can be pulled away.

The use of a Templistik can require more than one person. A case must be held rigid in a pan of water, using wire pushed down into the case against the primer pocket while ensuring the wire does not touch the case neck and act as a heat sink. The person (wife) holding the wire also holds the Tempilstik at the ready. Your job is to apply heat and count, then swing away and let your helper (now impatient wife) try to smear the stick. After a few cases, you may be able to work out a count and also a case color (if in a dark room). The helper (who probably won't talk to you for the next three days) is now no longer required, provided your gas torch heat remains consistent. There are other methods that can be utilized where the helper is not required, such as using a Lee trimmer lock stud and heavy aluminum sleeve as a heat sink. The Lee lock studs can also be fixed in a water heat sink with a bit of know how.

Annealing cases in a pan of water.

The most useful heat indicators are the hand held infrared thermometers. A good thermometer can be somewhat pricey but is certainly less fiddly than a crayon. Anyone serious about annealing really needs to consider one of these for temperature accuracy.

If annealing my preferred process is to anneal cases, then full length size and fire form. The full length sizing and fireforming steps are utilized in an attempt to create a degree of uniformity amongst cases. But if you look at my method, it is somewhat flawed. The cost of powder and a bullet for each case is no less than buying new brass. And from this you can see why I try to avoid annealing unless I have to. I only anneal if brass for a cartridge is hard to come by or where the cost of brass is a significant factor.

In recent years a few small business operators have produced rotary automated annealing systems. These still require a degree of experimentation to set up. But with the aid of an accurate thermometer blow torch heat can be regulated to produce consistent results.

Summary of Key Points:

- Annealing is useful but temperature control is problematic.
- Try to use a temperature indicator if high accuracy is to be expected.
- Consider an automated process.
- Consider fireforming step as a means to uniform temper.
- Keep case head cool during annealing (heat

sink).

- Anneal case neck and shoulder- cool slowly.
- Sometimes better to start over with new brass.

Chronographs

In the precision shooting game a chronograph to measure the velocity of ammunition has to be one of the best investments a handloader can make. And it doesn't have to break the bank either. With a degree of experience the handloader can use the chrony to not only establish and potentially improve velocities but also to observe the relationship between velocity and pressure. As we approach near maximum, the chrony will often show large variations in velocity as the rifle experiences pressure spikes. This information along with enlarged group sizes and case head indicators can all be used to gain a full picture of velocity pressure relationships. We can also see if the rifle is somewhat underloaded. Long range shooters can use a chrony to predict bullet drop at long ranges with a high degree of accuracy, though field testing is still very important. The long range hunter can also use a chrony to study ES (extreme velocity spread) - a great adversary at long ranges. If the ES is high, projectiles may show over a yard / meter of vertical dispersion when shooting at long ranges.

Example of measuring ES and average velocity:

Result of three shots = 3122fps, 3110fps (lowest), 3125fps (highest).

3125 - 3110fps = 15fps. The ES of this load is 15fps.

15fps divided by 2 = 7.5fps.

3110fps + 7.5fps = 3118fps (rounded up). 3118fps is therefore the average velocity of this load.

If we are shooting at long ranges, we can now plug both the high and then the low velocity figure into our ballistics software. We can then see just how much vertical dispersion the load will produce at varying distances and whether the load is acceptable. If it is, we can then set about making a drop chart based on the average velocity.

I have stuck to just the one brand of chrony over the years - the Shooting Chrony F1. This has been the cheapest chronograph on the market, and as far as accuracy of readings goes the proof can be found when testing bullet drop at long ranges in conjunction with a good ballistic software program such as Sierra Infinity. Either the chrony reads true or it doesn't. There are other very good brands on the market such as Oehler - again, very accurate. Oehler go one step further by having a proof system in place to minimize errors. A more recent design is a magnetic chronograph which attaches to the barrel of the rifle, being less sensitive to environmental conditions. My F1's are quite sensitive to lighting conditions and give the best readings on overcast yet bright days. Unfortunately I have not had a chance to test a barrel mounted magnetic chrony. My main concern with this design is that there is potential for the unit to have an effect on barrel harmonics. This means that loads need to be tested with and without the unit attached to

the barrel, causing a double up of testing. Readers need to bear in mind that my concern is theoretical. Each rifle should be tested on an individual basis to see if harmonics are indeed altered.

The traditional chronographs come with decent instructions which should be read carefully. When using a traditional chronograph, make sure that the chrony is aligned square to the bore and set at a good distance of around 12 to 14 feet from the muzzle of the rifle. If the chrony is too close, the unit may give false readings and show a wide and incorrect ES. The only time we can use a chrony at closer ranges is when using low powered cartridges or testing arrows. The general rule is, the bigger the bang the further away the chrony needs to be. On sunny days the chrony will need its white screens (diffusers) fitted. On cloudy days the screens need to be removed to increase light, using the cloud as the back ground. If readings seem very unusual, you will need to retest under different lighting conditions. If you are working towards extreme accuracy, repeat testing and confirmation of sweet spots with handloads is a normal process and will give you a second chance to observe chrony speeds. But again, if you are looking for very precise readings I would advise setting the chrony out at 12-14 feet. I do not bother to correct for velocity at the muzzle. I simply set about plotting trajectories and testing the rifle at long ranges.

Shooting the .338 Edge through an F1 chronograph.

Before we leave the subject of chronographs, I really want to reiterate just how useful a chrony can be in real world terms. On occasion I will come across a bloke who is loading for his rifle. He has got close to book max and is a complete bundle of nerves, worrying that he is at the limit and about to blow the rifle to pieces. But instead, the only thing going to pieces is his shooting technique. The trouble is, that rifle may be yielding up to 300fps below its potential and be well within its acceptable pressure limits. It may simply have such a long throat that it's basically walking the bullet out the door, checking the mail and letting the dog have a pee. All those nerves, flinching and an underperforming rifle for no reason whatsoever. On the other side we can use chrony readings in conjunction with case head observations when looking for signs of high and potentially dangerous pressures. So, it works both ways - a very cheap and handy tool. And finally, in some cases a chrony can help us to develop more ethical fast killing loads. Don't be fooled by folk who state that handloading or 100fps make no difference to game killing. Such a statement is misleading because in truth

there is often more to be gained than 100fps. Yes, 100fps are no big deal and should not be chased if pressures or accuracy are going to be compromised. But I often see much greater variations than this. Sometimes we can be 250fps below and as much as 300 to 400fps below optimal working pressures. When we load small bore hunting rifles slow and the bullet is not optimally suited to these velocity parameters, the results can be very poor.

Summary of Key Points:

- Chronographs are extremely useful.
- Modern units are relatively inexpensive.
- An aid to ethical game killing.
- Essential for long range shooting.
- Place chronograph 12-14ft from rifle.
- Monitor light conditions. Light white background essential for good readings.

Handloading for older military bolt action rifles

From time to time you will hear such comments as the Mauser action being one of the strongest actions ever made. On another day you may hear comments that some Mausers are weaker than others and that some need to be loaded to very mild pressures. Old rifles can certainly be a mixed bag, so let’s see if we can work our way through this.

OK, to begin with if an action is very weak, the point at which the brass case fails may be only just below the point at which the action fails. Why? Because pressure is non- linear. That action steel may be a bunch stronger than a wee willy winky case, but if the pressure spikes exponentially we may find that our action is very close to failure.

So, what do we know about the old rifles chambered for modern smokeless powder cartridges? To begin with, the earliest muskets, rifle actions and barrels were made with whatever steel was at hand.

The addition of carbon (alloy) or the infusion of carbon into the outer surface (case hardening) could be used to turn iron into a tough steel.

If we take a piece of high carbon steel, heat the steel to a bright red color and then quench it in oil, the outer layer will be hard while the inner steel will remain somewhat soft. In layman's terms, we can freeze the outer structure of the steel to create a super hard exterior while the slow transfer of heat away from the inner metal creates a softer interior that is less brittle than the outer. The hard and soft properties help achieve optimum strength. Longbow timber is much the same - a tough back combined with a pliable compressible belly - to prevent the bow from breaking when it is drawn and fired.

If we take a piece of mild steel and heat it until it is a nice bright red, the steel can be coated with carbon (carburized) which creates a super hard outer layer. If we carburize an already high carbon steel we can make the surface layer even harder. Regarding the carburizing method, the longer the steel and carbon are held together at high heat the more carbon enters the steel; but only to a point. Following this the part can be

quenched in oil. Again, the oil allows the outer surface to cool rapidly and the inner metal to cool somewhat more slowly.

A properly heat treated carbon steel action (whether alloy or infused) and a relatively high carbon heat treated barrel could achieve sound performance, provided the rifle design was equally sound and the actual processes were successful.

By the early 1900’s most gun makers were using a relatively high carbon steel. The alloy was still very basic, consisting of little more than Iron, carbon and manganese. The modern equivalent of this steel carries the industry code 1030.

There were however problems. The early 1903 Springfield rifles with serial numbers below 800,000 were sometimes made altogether too brittle. This occurred due to the use of an already relatively high carbon steel which became even harder due to additional case hardening combined with undesirable heat treatment processes. From the serial numbers 800,000 through to 1,275,967 Springfield adopted a secondary heat treatment process to alleviate the dangers of a brittle action. Then finally in 1928 Springfield adopted nickel alloy which was in use for gun making within Europe - including Britain.

The German military continued to use a basic carbon manganese steel similar to the original Springfield rifle steel. This had a carbon content of around .25 to .35% and was utilized throughout the production history of the Mauser rifles. However, we have to keep in mind that manufacturing locations and therefore steel supplies varied a great deal.

Mauser action steel consisted of (very roughly):

Manganese .60 to .90%

Carbon .25 to .35%

The balance mostly consisting of Iron.

The basic nickel alloy of this time period consisted of (again very roughly):

Nickel 2.75 to 3.50 %.

Manganese 0.35 to 0.75%.

Chromium 0.30 to .85%.

Carbon 0.25 to 0.35%.

The balance of the alloy being iron.

If we compare these to modern 4140 gun steel (chrome moly):

Manganese 0.65 to 1.10%.

Chromium 0.75 to 1.2%.

Carbon 0.36 to 0.44%.

Molybdenum 0.15 to 0.35%.

As a very rough summary, the earliest rifles were made with little more than carbon steel (iron with carbon and manganese). Many gun makers then moved on to using nickel alloy, followed by our modern alloys. The main changes between nickel alloy and 4140 alloy are the omission of nickel (corrosion resistance and strength), an increase in chromium content (tough, hard and both corrosion and wear resistant) and the inclusion of molybdenum (hard wearing, heat resistant). I believe the alloy 4140 was created sometime during the 1920's, but as to when it became employed in gun manufacturing, I do not know. I can

find no reference to its use in the gun industry during the 1920's and 1930's and can only assume that the demands of the second world war perhaps prevented its widespread adoption until the 1950's.

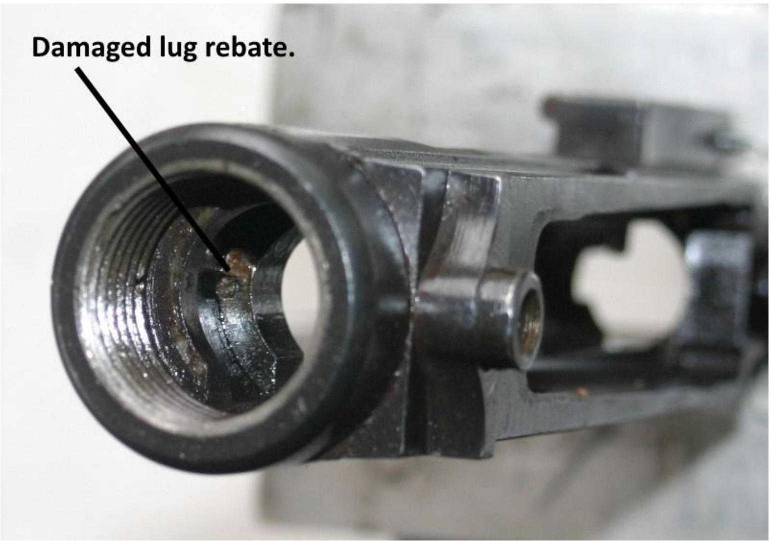
The production of the Mauser M98 was so widespread and the techniques varied so much, that it is impossible to state all Mausers were built via *X* method and have *X* quality. For example, by using a high carbon steel, manufacturers were often able to get away with heat treating (heated and quenched) rather than case hardening and heat treatment. These rifles had certain inner areas of the action case hardened with cyanide paste (another carburizing method). Areas case hardened included the bolt and lug rebates within the action. When the entire action was heat treated, the outer action was made hard due to the carbon content already within the steel while certain areas were harder still due to spot case hardening. But the overall strength of such an action was not as incredibly tough as one might think. Wartime demands also placed great strains on manufacturers which further affected quality.

Rockwell hardness testing can be used to determine the hardness of a steel and make comparisons between different steels. A Rockwell tester is about the size of a home workshop drill press. The part to be tested is placed on the press, a testing bit comes down (still in keeping with the drill press image) and is pushed against the steel to be tested. The depth of impact is measured on a gauge and from this we can determine hardness based on one of the Rockwell scales. In layman's terms, using the Rockwell C scale, the mid 40's can offer strength without being brittle, while hardness levels above 55 can be brittle - depending upon the components of the steel.

Heat treated Mausers generally produced Rockwell hardness levels averaging anywhere from 30 to the mid 40 range. Remington M700 actions are generally within the mid 40 range as a comparison. It is also true that some Mauser rifles were fully case hardened, bringing the surface layer up to Rockwell hardness levels of 45 to 50 or slightly higher. Case hardening depths of the day (spot or full case hardening) were typically .4 to .5mm or .015 to .020”- just a fine layer. But again, this could vary a great deal based on wartime demands.

Sixty to one hundred years later these old Mauser rifles can differ a great deal from the day they were produced. Many had their actions heated for barrel replacement during sporting rifle conversion. Any exterior hardness, whether as a result of basic heat treating or case hardening, could be lost when the outer layer of the actions were sanded and polished to remove military insignia for sporting purposes. The strength of the action could be compromised, if the action was later drilled and tapped for a scope and one of the drilled scope base screw holes happened to be right at the edge of a lug rebate. Dovetailing the action for scope bases also created potentially dangerous conditions.

Further difficulties included quality control problems with regards to the steel supplies, and finally hasty war time operations. If the lugs were lapped at some point when the rifle was sporterized, this could result in yet another weakening factor. When you think about it, it’s a bit of a lottery.



The VZ 33 is a somewhat rare rifle. The strength of this action has been compromised due to a scope base hole drilled into the edge of the top locking lug rebate.

We can now see why reloading manuals are so cautious when it comes to the old military chamberings. Further to this are the problems of bore diameter, such as the Germans changing from the .318” bore diameter to the .323” bore diameter. It’s quite safe to use .318” ammo in a .323” bore, but not the other way around. And when it really comes down to it, you can see how any blanket statements regarding a brand of rifle are quite out of place.

All vintage military rifles need to be treated on an individual basis. A Holland & Holland (K98 Mauser) can handle pretty dire conditions - hot shooting temperatures, dirty barrels and huge amounts of thrust. A beautifully polished Churchill rifle that has lost its temper may not be so tough. In fact during rebarreling

such an action may simply do the loop de loop when someone tries to remove the barrel it may end up looking like a wet dish rag being rung out. I have heard folk complain that their actions were ruined because a gunsmith twisted their rifle action during barrel removal. If this happens to you, be grateful. The smith may have saved you from potential injury!

The Lee Enfield action consisted of a nickel alloy. The action was heat treated but not case hardened (no outer carbon layer). In other words, the hard surface and soft inner came as a result of the properties within the steel combined with careful heat treatment techniques. When quenched in oil after heating, the outer steel of the Enfield cooled quickly and became hard while the inner remained softer. The only area that was case hardened was the bolt.

To Enfield engineers the use of nickel alloy in this manner was considered the best way to achieve a balance of hardness without the action being brittle. Each rifle (No.1 series through to 4) was then proof tested to approximately 48,000 PSI. The very last Enfield rifles were chambered for the 7.62 NATO cartridge (.308 Winchester) with military ammunition producing pressures similar to Enfield proof loads. No changes were made to the metallurgy of the action during these conversions - the 7.62 variants based simply on re-worked No.4 rifles.

From an end user perspective there is little we can do to determine the actual strength of an individual Enfield action beyond actual Rockwell Hardness testing. The No.4 rifles certainly had more meat to the action than the No.1. Nevertheless, the Enfield actions (all of them) certainly feel relatively soft during drilling, tapping and rebarreling operations. Enfield rifles were on occasion heated by DIY

gunsmiths during barrel replacement, so again there is a risk of poor temper with some actions. Without Rockwell testing it is important that we play it safe and (provided we have a sound action free from corrosion) stick with loads that duplicate military ammunition pressures.

A successful hunt with a Lee Enfield No.4 Mk1 .303 rifle. Hunting with an accurate military bolt action rifle can be immensely enjoyable.

No discussion on the strength of military bolt actions can be completed without bringing the Swedish Mauser into the fray. The Swedish Mauser is often cited as being weaker than the M98 for not having a third lug and being of a smaller diameter (called small ring) in comparison to the generally large ring M98 rifle action. But to me subtle factors hold equal weight. There were a few soft Swedes but for the most part they were tough. The rifles were generally proof tested to 66,000 PSI (the

maximum pressure rating for the .308 Win is 60,000 PSI) while ammunition was loaded to around 47,000 PSI. The Swedish utilized their own nickel alloy steel - a steel which they took great pride in. This steel was utilized in the same manner as in the German rifles, employing careful heat treatment procedures along with case hardening of select components. The Swedish armorers took a great deal of pride both in the selection of steel and its heat treatment. Temper did however vary to a degree based on the limitations of this time period.

All Mauser designs lacked a gas escape port on the side of the action as we see in modern rifles. The Mausers vented gas into the bolt, then through escape ports in the side of the bolt. But with the Swedish action the shooter would have to wear some surplus gas in the face, as the action lacked a gas stop flange in the bolt shroud - a feature added to the M98 which basically consisted of a washer at the front of the shroud. But for all of this, when a Swede goes bang and breaks to bits, it does so with a degree of dignity and does its best not to harm the shooter. Though the risk of injury with any action blow up is still very high. I have seen modern actions go bang with less dignity and more shrapnel, so can we really fault the Swede design? Yet again, we have to treat each rifle on an individual basis and we do need to exercise caution.

OK, so what can we make of all of this? To begin with, the first point to understand is that there is a level of confusion within the gun world regarding the temper of Mausers. Most folk have been under the impression that all Mauser actions were case hardened throughout the entire action. But on closer investigation, it appears that a harder surface layer was often achieved simply as a result of heat treatment, utilizing the carbon present within the base steel. This can therefore lead us

on to a realization that strength can indeed vary from rifle to rifle. The same variations of temper occurred with other military rifle designs of the world.

We also know that many rifles have been altered since their military days and that any of these alterations can potentially affect the strength of the action.

We start individual investigations of a rifle by first making visual observations. You can also perform your own research regarding the general history of a rifle design, but be careful when it comes to arguments based on what such and such said. Use your common sense and understand that each rifle should be studied on an individual basis. If you have any doubt as to the strength of your military rifle, I suggest you take the rifle to a gunsmith or a facility that performs Rockwell testing (hardness testing). Rockwell testing is not as uncommon as some may think with operators supporting various industries. The bolt can be tested by compressing the side of a locking lug. The outer surface of the action can be tested between scope base screw holes and on the side of the recoil lug.

There are various DIY ways we can test the strength of a rifle action, but it takes a lot of experience and none of these methods are as reliable as Rockwell testing. If the rifle has not been drilled and tapped for optics, drilling may give us an indication of case hardening. Another old method includes running a new file across an inconspicuous area of the action such as the corner of a recoil lug. If the file passes over the material and feels the same as if passing the file over a glass bottle, the outer layer of the action has indeed been successfully case hardened. If the new file cuts easily, the action is too soft for any serious load development. Again, neither of

these methods are as reliable as Rockwell hardness testing. I do not believe there is any fully reliable method for measuring the hardness levels of lug rebates. This is a difficult area of the action to access.

Without any other information, we can at the very least use case pressure signs in Mauser, Springfield and Enfield military bolt action rifles to gauge pressures. But please understand that we will reach a point where pressure is non-linear. The reloading manuals play it safe for good reasons. It is so important that you understand the need to treat rifles on an individual basis.

A good rifle action design should not only feature preventative measures but also incorporate a failure system in the event of an action rupture. This could either take the form of directing and venting gases away from the shooter; or for a more famous example, the third floating lug of the M98 Mauser design which engages only during action failure / rupture. More than once I have been tempted to drill gas escape ports into the side of a Swedish Mauser as a failsafe, but alas I have yet to experiment with this. I would prefer to utilize destruction testing rather than simply drilling a gas escape port and declaring that I have solved the argument for the Swede for all time.

I will say little more on this subject here, this chapter is simply a cautionary tutorial. I will be the first to admit that I like to run my Swedish and German Mausers at full power. Nevertheless, I am aware that there are potential dangers and I am always vigilant of the potential problems discussed within this section of this book.

I have not covered lever action tube loading rifles or older single shot rifles. The rules for these are fairly straight forwards: These

actions are designed to work at relatively low operating pressures regardless of age due to their design limitations. Reloading manuals offer good advice for such rifles.

Summary of Key Points:

- Research your rifle.
- Perform visual check of finish. Has the rifle been polished to remove milling marks, swastikas, etc.?
- If possible, check scope base holes versus position of lug rebate.
- If in doubt, take to gunsmith.
- Consider Rockwell testing the receiver (top front).
- File tests can be useful but require experience.
- Drilling and tapping of scope base very useful to determine action strength.
- Back off loads at first signs of pressure.
- Soft brand of primer (Winchester) or case (PRVI, Federal, Norma) can be used as an early warning pressure indicator as opposed to a tough primer and / or brass.

The following lists are quick reference guides. These can either be printed off (ebook) or photocopied from the paperback format. You can laminate or insert pages into a clear file, then attach these checklists to a wall near your load bench.

Preliminary load development checklist:

1. Make heading in journal and record components: Rifle, magazine length, brand of brass, primer, powder, bullet.
2. Measure and record test projectile length in journal.
3. Take rifle, find and record maximum COAL.
4. Determine appropriate bullet jump taking any freebore or magazine length issues into account.
5. Write down preliminary test loads.
6. Insert correct shell holder in press.
7. Set up sizing die (neck or full length). Careful not to overwork brass, careful not to crush seating stem.
8. Lube cases and inner case neck (if die requires lube).
9. Size new brass or recycle used brass.
10. Clean cases with cloth and cotton bud as each are removed from press.
11. Trim and chamfer cases. More chamfer on inner than outer.
12. Clean and or uniform primer pockets.
13. Flip cases upside down in block if possible.
14. Prime cases, make sure primers are seated flush or below flush.
15. Flare case mouth (if loading straight walled cartridge such as .44 Magnum, 45/70).
16. Set scale to zero, check accuracy, then set to start charge. One tin of powder on the bench only.

17. Fill cases with powder.
18. Set up seating die. Do you need to crimp? Some dies need to be backed off one turn to prevent crimping.
19. Label ammo.
20. Pack PPE, targets, chrony, cleaning equipment, sandbags, liquids and boonie hat for range work (yes, you need a decent sized range bag).
21. Fire off ammo (first batch will be fireforming).
22. Note any accurate loads in journal (if performing preliminary incremental load tests).
23. Reset sizing die to correlate with correct rifle head space.
24. Work up accuracy test loads with fireformed cases in half grain increments.
25. Note accurate loads in journal.
26. Load more ammunition (if need be) to determine near maximum.
27. Observe sweet spots and work around sweet spots in .2 grain increments to fine tune accuracy.
28. Note accurate loads in journal.
29. Troubleshoot as necessary, if accuracy remains poor.

Ongoing handloading checklist:

1. Refer to journal for pet load.
2. Insert correct shell holder in press.
3. Insert neck or full length sizing die in press.
4. Lube cases and inner case necks (if die requires lube).
5. Size brass (if continuously neck sizing, it can pay to check that cases still chamber without heavy resistance).

6. Clean cases with cloth and cotton bud as each is removed from press.
7. Check case lengths - do any need trimming, chamfering and polishing?
8. Clean primer pockets.
9. Flip cases upside down in block if possible.
10. Prime cases, make sure primers are seated flush or below flush. Make sure you use the same primer as recorded in your journal.
11. Flare case mouth (straight walled cartridges only).
12. Set scale to zero, check accuracy, and then set to pet load. Fill cases with powder.
13. Insert seating die.
14. Seat projectiles.
15. Clean and spray dies with a light lubricant to prevent corrosion during storage. Lube will need to be removed from inner die body before next reloading session to prevent potential contamination of powder.
16. Check accuracy from time to time. If accuracy drops due to throat / bore wear, re-work loads: seating depth and possible increase in powder charge (small increments).

Brass prep for precision shooting prior to preliminary load development

1. Batch weigh brass - cull off extremes and / or select weight range. You choose parameters.
2. Uniform primer pocket.
3. Uniform and debur flash hole.
4. Run brass through expander die.
5. Skim neck turn.

6. Neck size.
7. Fire form.

Typical progression of load development.

1. Fireforming with Trail Boss.

2. Preliminary load work, up to book maximum.

3. Load work, up to rifle maximum.

4. Explore sweet spots.

Or:

1. Preliminary load work and fireforming combined, up to book maximum.

2. Load work, up to rifle maximum.

3. Explore sweet spots.

Redding die set options.

Redding offer a confusing range of products, making shopping perhaps more difficult than it should be. The following is a basic list of options to help readers.

1. Traditional two and three die sets. These are listed as series A,B,C,D - ranked on cartridge popularity. In other words, the common .270 Win is a series A while the far less common .470 Nitro Express is a series D and priced slightly higher.
2. Type S Match Full Bushing Die Set (two die set). This set contains a full length sizing die which utilizes a floating

neck bushing for optimum concentricity, plus a micrometer seating die.

3. Type S Bushing Die Set. Contains a neck bushing die without micrometer, a body die and a regular (traditional seating) die.
4. Type S Match Bushing Neck Die set (three die set). This set contains a neck bushing die without micrometer, a body die (not bushing style), plus a micrometer seating die.
5. Competition Neck Bushing Die Set (three die set). This set contains a micrometer style neck bushing die, a body die and a micrometer seating die. The neck sizing die for this set has an inner collet (similar to Forster dies) to help guide the case up as it is presented to the neck bushing.
6. Carbide pistols dies.

Redding offer plenty of other options along with individual items and no doubt this list will change as time goes by. There are certainly plenty of choices for the serious reloader, but I do find the current inventory is far too overwhelming for those new to reloading. Those starting out in the accuracy game may simply wish to adopt option 4 - the Type S Match Bushing Neck Die Set. Redding (in competition with Lee) now also produce a separate crimp die available in select chamberings.

Glossary

Please note, descriptions are generally provided within this book. This basic glossary is provided as a secondary quick reference.

BC - Ballistic Coefficient. Using the G7 model, the higher the BC, the more aerodynamic the projectile.

Belted cartridge - A British design (Holland & Holland), consisting of a hefty ring of brass just forwards of the case rim. The belt was designed as a solid, positive stopping point (head space) to help ensure reliable extraction in African dangerous game hunting rifles. Outside of this role the belt can be ignored and cases head spaced off the shoulder. Although some folk have over the years complained that belted cartridges do not feed as smoothly as non-belted designs. Belted cartridges can display increased strength at the area of the case head and the belt can be very useful for fireforming, especially when fireforming wild cats. Feeding issues can generally be rectified by addressing rifle issues and also human error when loading rifle magazines.

Boat tail - Tapered rear section of a bullet. A boat tail bullet is utilized as a means to decrease bullet drag.

Bullet - Refers to a projectile, not a loaded cartridge. The word bullet is however sometimes used in a colloquial manner to describe the entire cartridge. It is therefore important to observe how this word is used within the construction of a sentence, as mix-ups do occur. Example of misuse of term: “Where the heck is that pack of twenty two bullets (loaded .22 LR ammunition), I am sure I had them in my right pocket. Bugger.” The correct response to this is: “Have you checked

your other pants dear? You did get changed earlier - if you remember."

Bullet body - My term used to describe the generally parallel section of a projectile. The correct term is bearing surface (which I also manage to squeeze in from time to time).

Bugger - An antipodean term, used either on its own for whatever reason, or no particular reason, and / or to emphasize any point.

Case body - The body of the case between the rim and shoulder.

Case head - The base of a cartridge case (rim area).

Case head separation - The separation (splitting) of the case head and case body. This can be caused by either excessive head space and / or overworking the brass during case sizing operations. The term incipient case head separation is commonly used in the gun industry and refers to the beginning of case head separation caused by overworking brass. The beginning of case head separation can be felt by pushing a piece of wire down into the case, feeling for a bump (raised ring) within the case, just forwards of the case head.

Case rim - Present on all cartridges, whether the case is called rimmed, rimless or rebated rim. The rim is used for extraction of the case from the chamber.

Case shoulder - Literally the shoulder section of a case behind the case neck. During the black powder era and the beginning of the smokeless powder era the case rim was utilized as a stopping point (the stop point called head space) to prevent the case jamming in the chamber or travelling into the bore after

ignition. Rimmed cartridges were however prone to jamming in military magazine fed rifles if not stacked correctly. The solution was the modern rimless cartridge. Contrary to the description, the rim remained, however it did not protrude to a diameter wider than the case. A case shoulder was then incorporated into the design as a stopping point within the chamber (head space). Rimmed cartridge designs are still heavily utilized for lever action rifles, break open rifles and revolvers.

Case web - Area of the case just forwards of the case rim. In essence, the beginning of the case body.

Chamber - The beginning of the rifle barrel, cut to the shape of the cartridge. The chamber is not a part of the rifle action.

COAL - Cartridge OverAll Length from the rim of a cartridge case to the tip of the projectile, or a reference point on the ogive depending on method of measurement.

Concentricity - By definition, if we place a small circle inside a large circle, the circles will be concentric when they share the same center. In handloading terms, this means the round bullet being concentric with the round holey bit we call the bore.

ES - Extreme velocity spread. When recording velocities we can record not only the average velocity but also the highest and lowest velocities as a means to predict vertical dispersion of shots at long ranges. A fast bullet will strike high, a slow bullet will strike low.

Expander button - This is found on the decapping (depriming) stem of a neck sizing or full length sizing die. Some brands of die do not have an expander button. After a die makes the case neck undersized, the oval shaped expander button expands the

case neck as the case is drawn out of the press. Dies that undersize a case neck, then expand with a button are often prone to cause poor case concentricity via the somewhat aggressive sizing process.

Fireforming - The act of firing a cartridge to change the shape of the cartridge case, so that it more closely matches the individual chamber of the rifle and is therefore more concentrically aligned with the bore.

Flat based bullet - A conventional projectile base / heel design with no boat tail (rear taper). This design is still highly useful as a means to aid penetration via increased mass at the shank. A flat based bullet might also behave differently within the bore of a rifle and can therefore be used during accuracy experimentation in comparison to boat tailed bullet designs.

Flat point bullet - As its name (though an oxymoron) suggests, the front of the bullet has no point and is flat. The bullet may also feature a hollow point (hollow flat point). Within the context of this book, a flat point bullet design is essential for safety when loading for tube magazine fed rifles. A pointed bullet could potentially cause ignition of primers within the magazine of a tube loading rifle. Flat point bullets can also deliver energy on target in a highly effective manner.

Heel of bullet - The heel is the rear most surface or base of a bullet.

Meplat - Tip of a projectile.

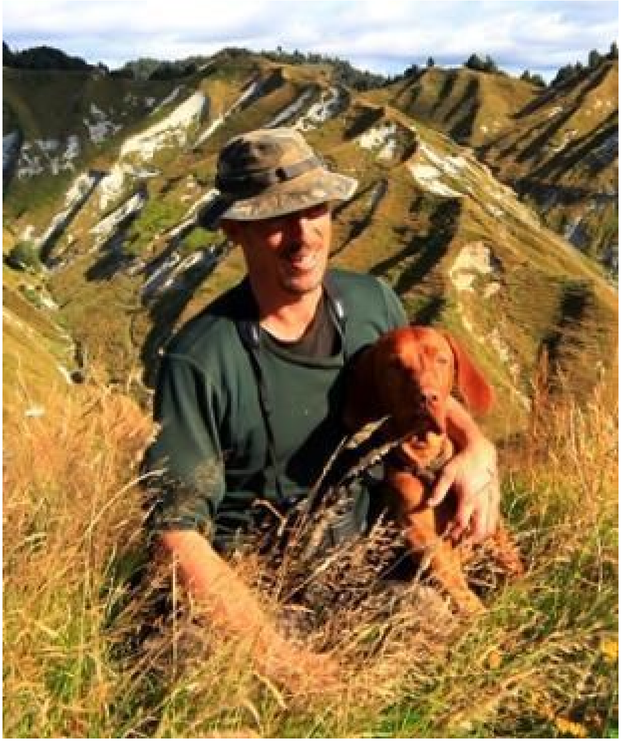
Ogive - The tapered section at the front of a projectile leading to the tip (meplat).

Overbore cartridge - A cartridge of very high powder capacity but with a small bullet / bore diameter relative to its case capacity. overbore cartridges can produce very high barrel (throat) wear along with very high pressures. The 8x57 and .30-06 have a good case to bore ratio. The 7mm RUM has a poor case to bore ratio and is overbore.

Run out - A term used when describing any lack of concentricity of either a case or loaded cartridge relative to the bore.

Wildcat - A custom made cartridge design. To make a wildcat, a custom designed reamer is used to cut the chamber of a barrel to individual specifications. Custom dies are then required to handload for the wildcat. Some of the more common wildcats are very much standard items today and reloading dies are often held in stock by die manufacturers.

Work hardened - The mechanical working and deformation of brass (and other metals) changes its crystal structure. Regarding brass: after continued firing and sizing a point is reached where the brass loses malleability and becomes hard, yet brittle, and is therefore prone to splitting.



Nathan Foster lives and breathes what he teaches. Nathan has a long established background in the gun industry, recognized for his extensive research and for educating and supporting hunters around the world.

Nathan has taken over 7500 head of game, testing the performance of a wide range of cartridges and projectiles. Nathan is an expert in the field of terminal ballistics who is recognized worldwide. His ongoing research has been carefully recorded, analyzed and documented in his online cartridge Knowledge Base for the benefit of all hunters and shooters (www.ballisticstudies.com).

Rifle accurizing and long range shooting are among Nathan’s specialties. For many years, Nathan has provided both rifle accurizing services and a long range shooting school. Nathan is also the designer of MatchGrade bedding products and has assisted many 1000's of hunters worldwide to improve their rifle accuracy, shooting technique and hunting success.

The Practical Guide To Reloading draws on Nathan’s many years of experience accurizing rifles and developing extreme accuracy level handloaded ammunition.

Broken down into a clear and concise guide, this fourth book of the Practical Guide series takes the reader step by step through the process of handloading ammunition - from the very basics for beginners through to advanced handloading techniques. Information is provided in user friendly layman’s terms to help readers of all levels of experience achieve their goals.